News about

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better extrusion

better calendering

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As a plasticizer both in nitrile rubber and vinyl plastisols, Hycar 1312 is non-extractable, non-migrating and non-volatile. It provides nitrile rubber compounds with excellent building and knitting characteristics —has good tack. Examples of applications where it is being used include tank linings, building of rolls and fabrication of hose.

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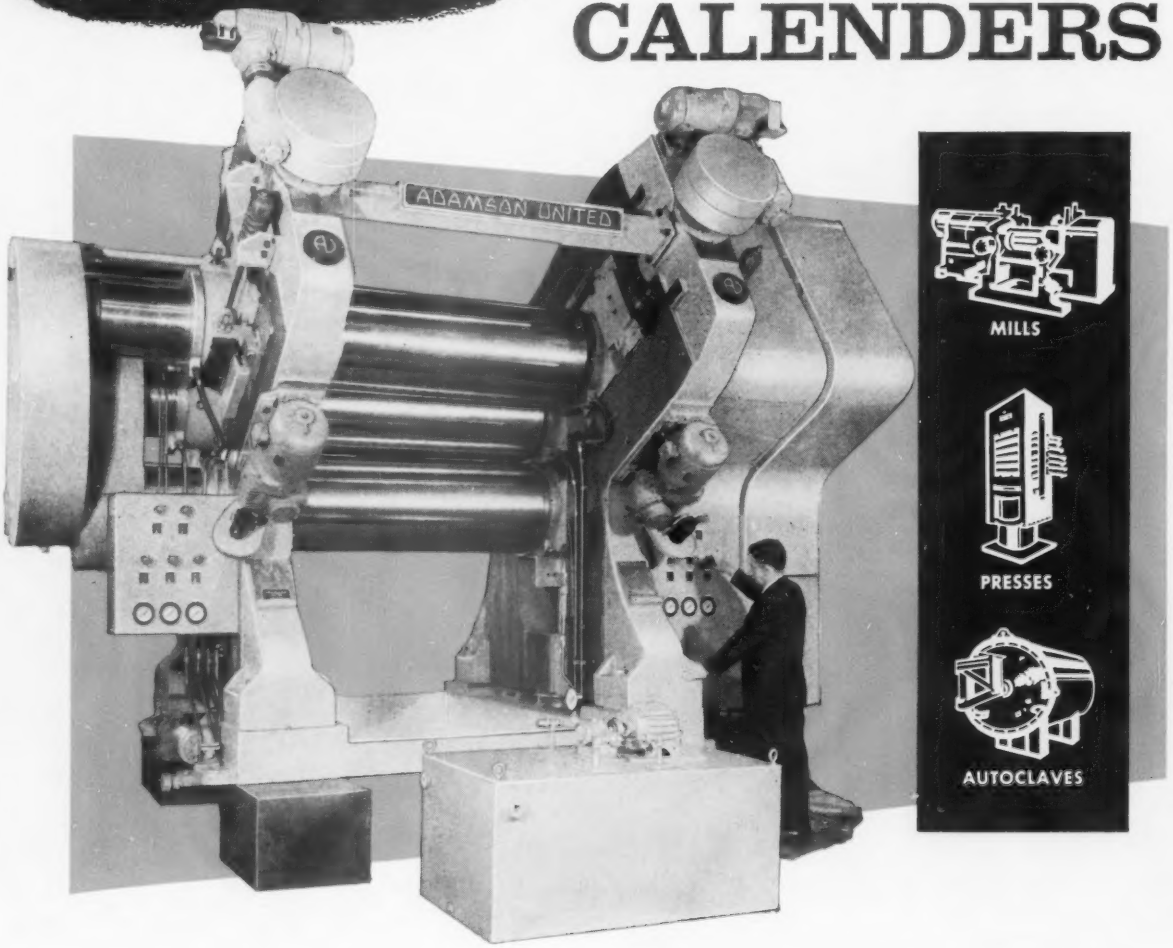
GEON vinyls • HYCAR rubber and latex • GOOD-RITE chemicals and plasticizers

ADAMSON UNITED

PRECISION CALENDERS



Whether the project calls for supplying all mills, calenders, presses and associated machinery for a completely new and modern rubber or plastics plant, or a single unit for a new process, you'll find Adamson United equipment offers the most efficient design and up-to-date operating features for today's production requirements. Our full line of modern rubber and plastics calendering equipment is an outstanding example.

Adamson calenders are skillfully engineered for production of close tolerance, high quality material at high speed. Standard sizes range from 8" x 16" laboratory models to large production units with rolls measuring 36" x 92". Various types include 2, 3 and 4 rolls; vertical, 120 degree, inverted-L, Z-type, cascade, inclined and others. The unit illustrated is a 3-roll, 120-degree, connecting gear-type calender equipped with roll crossing. Adamson calenders are also available with such precision operating features as roll bending, zero clearance, flood lubrication, drilled rolls, anti-friction bearings and pinion-stand drive.

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Rubber Age

COVERING THE MANUFACTURE OF RUBBER AND RUBBERLIKE PLASTICS PRODUCTS

JANUARY, 1961 VOL. 88, NO. 4

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CARL S. HOGLUND
5107 Telegraph Road
Los Angeles 22, Calif.
Phone: Angelus 1-8136

PHIL GLANZER
223 Coldstream Ave.
Toronto 12, Ont., Canada
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An editorial appraisal of the rubber industry and comments by industry leaders written expressly for the readers of RUBBER AGE.

643 Compounding Oil-Resistant Silicone Rubber—By Robert L. Daileader

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650 The Vulcanized-on-Sole Process. Part IV—Conclusions—By A. W. Niconchuk

The final portion of this informative four-part series covers special studies and includes suitable soling stocks for the vulcanized-on-sole process.

658 Attrited Carbon Blacks and Their Behavior in Elastomers. Part III—Effect of Attrited Blacks on SBR and Other Rubbers—By A. M. Gessler

The final paper in this three-part series considers the effect of attrited blacks in SBR and other elastomers with much higher unsaturation than butyl rubber.

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*Appears every other month

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HUBER

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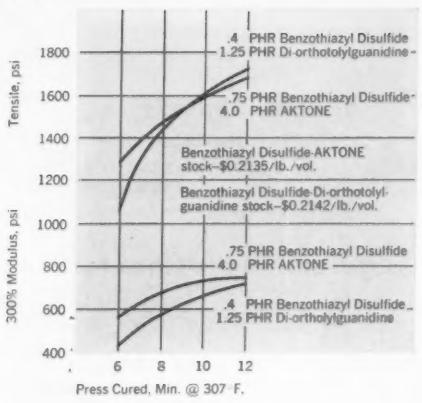
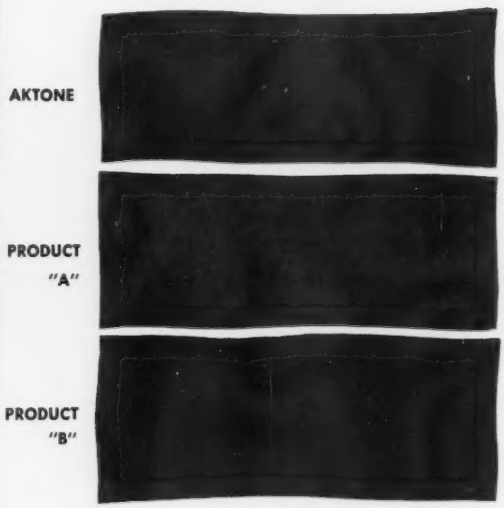
HS Resin	25	25
RPA #3 Conc.	1	1
ZEOLEX 23	58	58
SUPREX CLAY	12	12
Zinc Oxide	3	3
Stearic Acid	4	4
Cumar MH2½	15	15
Staybelite Resin	7.5	7.5
Carbowax 6000	1.5	1.5
NS Antioxidant	1	1
AKTONE	4	—
MBTS	.75	.4
DOTG	—	1.25
Sulfur	3	3
Unicel ND	9	9

Activation



Dispersion (at 210° F)

AKTONE vs. Competitive Ureas



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Highlights Sidelights *of the News...*

January, 1961

A RUBBER AGE exclusive: Dr. William C. Wake (Rubber & Plastics Research Association of Great Britain) evaluates papers presented at the International Rubber Conference sponsored by Deutsche Kautschuk Gesellschaft on October 4 to 8, 1960 in Berlin (page 676).

Polymer Corp., Sarnia, Ontario, appears to be embarking on a $40 million program to broaden its home production and build up its competitive position in the world-wide rubber market (page 690).

The Research Association of British Rubber Manufacturers has changed its name to the Rubber and Plastics Research Association of Great Britain (page 683).

Acquisitions: Witco Chemical Co., has acquired Sonneborn Chemical & Refining Corp., and its subsidiaries in exchange for newly-issued 300,000 shares of Witco stock (page 703); the board of directors of Hewitt-Robins, Inc., has approved the acquisition of Union Chain & Mfg. Co. The move is expected to increase Hewitt-Robins sales about 10 per cent (page 675); Rubber Industries, Inc., has been acquired by Flo-Tronics, Inc., through an exchange of stock (page 701).

J. D. Mahoney has been elected president of Mobay Chemical Co., succeeding J. R. Eck, who has rejoined Monsanto Chemical Co. (page 685).

General Tire & Rubber Co., has offered licenses to the rubber industry under the patent recently awarded to the firm for its High-Mooney oil-extended rubber (page 674).

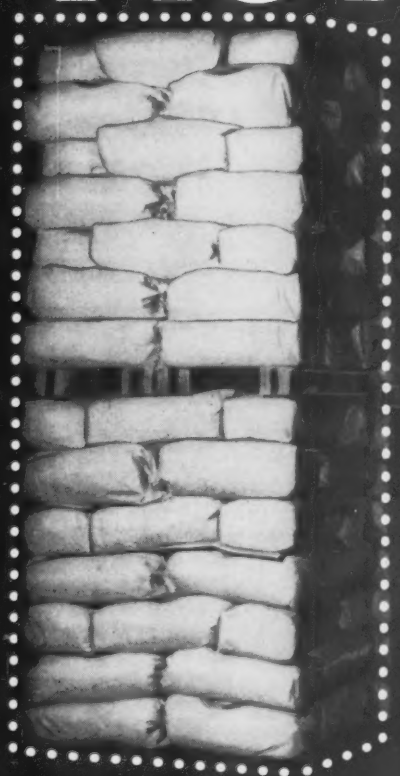
Rubber groups: The Northern California Rubber Group honored its past presidents (page 695); J. S. Islinger (Armour Research Foundation) discussed the role of elastomers in space before the Chicago Rubber Group (page 675); the Connecticut Rubber Group heard a discussion on the use of X-rays in the rubber industry by Raymond C. Lindert (Armstrong Rubber) (page 697).

Rubber Latex Products, Inc., and Harrison & Morton Laboratories, Inc., have filed suit to protect their processes for the manufacture of rubber tubing used in blood transfusions page 703).

The ACS Division of Rubber Chemistry has named Robert M. Murray and J. Donald Detenber as the next recipients of its Best Paper Award (page 674).

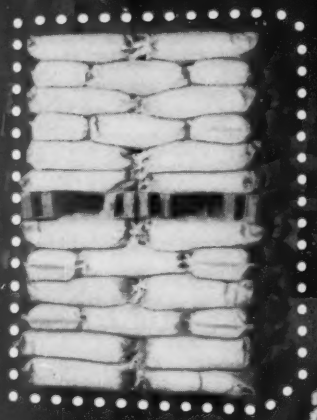
PROTOX®-267

ZINC OXIDE



Two units on left contain 84 bags—
2.1 tons conventional zinc oxide.
(Each unit 6 bags per layer, 7 layers high.)

Two units on right contain 96 bags—
2.4 tons Protox-267 zinc oxide.
(Each unit 8 bags per layer, 6 layers high.)



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coming events

Jan. 17. Elastomer & Plastics Group, Northeastern Section, ACS, Technical Meeting, Science Park, Boston, Mass.

Jan. 19. Quebec Rubber & Plastics Group, Technical Meeting.

Jan. 20-21. Southern Rubber Group, Statler Hilton Hotel, Dallas, Texas.

Jan. 24-27. Society of Plastics Engineers, 17th Annual Technical Conference, Shoreham and Sheraton Park Hotels, Washington, D. C.

Jan. 26. Tire Retreading Institute, Administrative Committee Meeting, Seville Hotel, Miami, Fla.

Jan. 26-27. Engineering Institutes on Nondestructive Testing, University of Wisconsin, Madison, Wisc.

Jan. 26-27. Southeastern Texas Section, ACS, 4th Symposium on Hydrocarbon Chemistry, Shamrock Hilton Hotel, Houston, Texas.

Jan. 27. Akron Rubber Group, Technical Meeting, Sheraton Hotel, Akron, Ohio.

Jan. 27. Chicago Rubber Group, Technical Meeting, Furniture Club, Chicago, Ill.

Jan. 27-28. National Tire Dealers & Retreaders Association, Executive Committee Meeting, Seville Hotel, Miami, Fla.

Jan. 28-Feb. 1. National Automobile Dealers Association, 44th Annual Convention, San Francisco, Calif.

Jan. 30-Feb. 3. American Society for Testing Materials, Committee Week, Netherland Hilton Hotel, Cincinnati, Ohio.

Jan. 30-Feb. 2. Plant Maintenance and Engineering Show, International Amphitheatre, Chicago, Ill.

Jan. 31-Feb. 1. ASTM Committee D-24 on Carbon Black, Netherland Hilton Hotel, Cincinnati, Ohio.

Feb. 1-3. Committee D-11 on Rubber and Rubber-Like Materials, ASTM, Netherland Hilton Hotel, Cincinnati, Ohio.

Feb. 3. Akron Polymer Lectures, "Some Aspects of Anionic Polymerizations," University of Akron, Akron, Ohio.

Feb. 3-5. Boston Rubber Group, Ski Weekend.

Feb. 7. Los Angeles Rubber Group, Technical Meeting, Biltmore Hotel, Los Angeles, Calif.

Feb. 7-9. Society of the Plastics Industry, 16th Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.

Feb. 7-9. Textile Technical Federation of Canada and Primary Textile Institute, 2nd Canadian Textile Conference, Queen Elizabeth Hotel, Montreal, Quebec, Canada.

Feb. 8. American Association for Textile Technology, Annual Meeting, Hotel Commodore, New York, N. Y.

Feb. 9. Fort Wayne Rubber & Plastics Group, Technical Meeting, Van Orman Hotel, Fort Wayne, Ind.

Feb. 9-11. National Society of Professional Engineers, Winter Meeting, Hotel Fort Des Moines, Des Moines, Iowa.

Feb. 16-19. International Automotive Service Industries Show, co-sponsored by Automotive Service Industries Association and Motor & Equipment Manufacturers Association, Los Angeles, Calif.

Feb. 19-23. American Institute of Mechanical Engineers, Annual Meeting, St. Louis, Mo.

Feb. 20-22. National Tire Dealers & Retreaders Association, Suppliers and Exhibitors Meeting, Sheraton Cleveland Hotel, Cleveland, Ohio.

Feb. 22-24. Material Handling Institute, Pacific Coast Show, Cow Palace, San Francisco, Calif.

Feb. 23-24. Protective Coatings Division, Chemical Institute of Canada, Divisional Conference, Toronto, Ontario, Canada.

Feb. 24. Quebec Rubber & Plastics Group, Ladies' Night, Victoria Hall, Montreal, Quebec, Canada.

Feb. 26-March 2. American Institute of Chemical Engineers, National Meeting, New Orleans, La.

Feb. 28-March 3. ASTM Committee D-13 on Textile Materials, Sheraton Atlantic Hotel, New York, N.Y.

March 1. Institution of the Rubber Industry, Joint Meeting with the Plastics Institute on Rubber and Plastics in Cables, London, England.

March 3. Akron Polymer Lectures, "Thermal Decomposition of Unsaturated Materials," University of Akron, Akron, Ohio.

March 5-9. American Society of Mechanical Engineers, Aviation Conference, Statler Hilton Hotel, Washington, D. C.

March 7. Los Angeles Rubber Group, Technical Meeting, Los Angeles, Calif.

March 10. Chicago Rubber Group, Technical Meeting, Furniture Club, Chicago, Ill.

March 11-15. National Association of Secondary Materials Industries, 48th Annual Convention, San Francisco, Calif.

March 13-17. National Association of Corrosion Engineers, Annual Conference, Statler Hotel, Buffalo, N.Y.

March 14. Ontario Rubber Group, Joint Meeting with Wellington-Waterloo Section, Chemical Institute of Canada, Walper Hotel, Kitchener, Ontario, Canada.

March 16-17. American Society of Mechanical Engineers, Textile Engineering Conference, Clemson College, Clemson, S. C.

March 17. Boston Rubber Group, Spring Meeting, Somerset Hotel, Boston, Mass.

March 21-23. American Physical Society, High Polymer Physics Division, 21st Annual Meeting, Monterey, Calif.

March 21-30. American Chemical Society, 139th National Meeting, St. Louis, Mo.

March 23. Quebec Rubber & Plastics Group, Technical Meeting, Montreal, Quebec, Canada.

March 24. New York Rubber Group, Spring Meeting, New York, N. Y.

April 18-21. Division of Rubber Chemistry, American Chemical Society, Spring Meeting, Brown Hotel, Louisville, Ky.

THIS TIRE WILL BE PERSISTENTLY PROTECTED AGAINST O_2 AND O_3

BECAUSE IT'S COMPOUNDED WITH WING-STAY 100

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CHEMICAL DIVISION

Here's why **WING-STAY 100**

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1. WING-STAY 100 is slowly consumed by oxygen – Many antioxidants or antiozonants protect against oxygen, but are rapidly consumed in the process. Result: Little or no protection against ozone remains. WING-STAY 100 is consumed only slowly . . . its effective resistance remains longer to provide maximum ozone protection.

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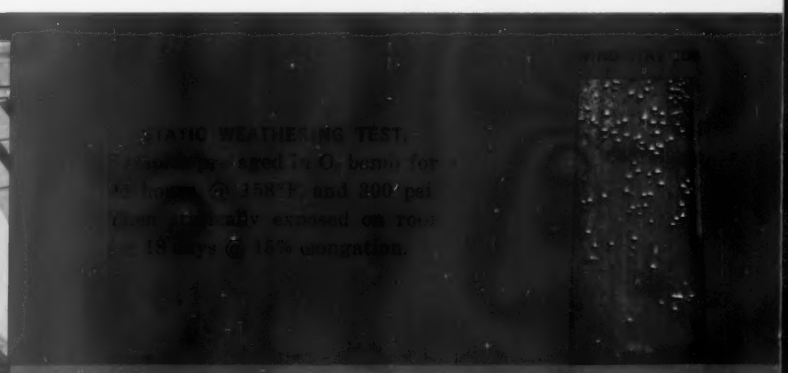

DYNAMIC WEATHERING TEST:
Samples pre-aged in O_3 bomb for 96 hours @ 158°F. and 300 psi. Then flexed on rooftop machine for 18 days @ 15% elongation.

Then add these advantages of **WING-**

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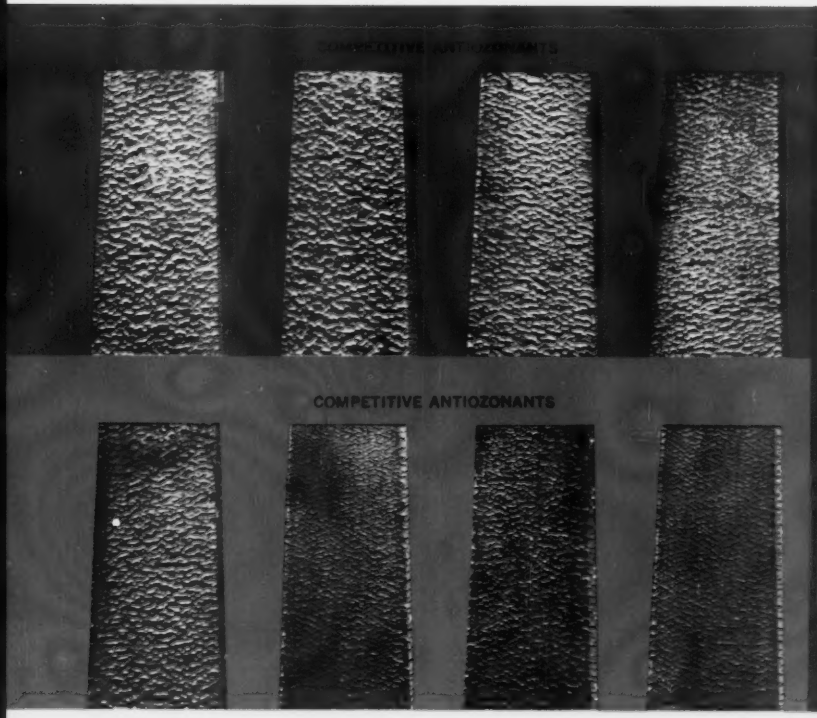
GOOD

persistently protects against O_2 and O_3:

2. WING-STAY 100 is more compatible with rubber—A number of antioxidant/antiozonants have limited compatibility with rubber. Result: They migrate rapidly to the surface and are lost by volatilization. WING-STAY 100 is much more compatible—provides a highly desirable, highly protective light "bloom."

3. WING-STAY 100 is less volatile—WING-STAY 100 is inherently low in volatility. Result: In contrast to the excessive "bloom" of many competitive materials, which quickly disappears, the light "bloom" of WING-STAY 100 resists volatilization by the heat and air flow of a moving tire—persists in its protection.

protection of WING-STAY 100:



FORMULA FOR TEST SAMPLES—DYNAMIC AND STATIC WEATHERING

PLIOFLEX 1500	100.00 parts
Zinc Oxide	3.00 "
Stearic Acid	1.50 "
HAF Black	50.00 "
145 M.P. Paraffin	0.50 "
Asphaltic Softener	10.00 "
Sulfur	1.75 "
Altax	1.25 "
DPG	0.40 "
plus	
WING-STAY 100	2.00 "

(or equivalent cost volume of competitive antiozonant)

STAY 100:

1. WORKS EFFECTIVELY AS STABILIZER, ANTIOXIDANT AND ANTIOZONANT
2. INCORPORATES EASILY
3. DOES NOT ACCELERATE CURE

YEAR CHEMICAL DIVISION

GOODYEAR

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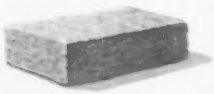
1. AS AN ADDITIVE—in easily handled, flaked, solid form for rapid incorporation into the rubber of your choice through normal compounding procedures—to give your tires, mechanical goods or other products much better over-all protection at lower cost.



2. ALREADY INCORPORATED—*at no extra cost*—in PLIOFLEX 1500C (cold, nonextended, staining SBR), PLIOFLEX 1710C (cold, staining SBR, extended with 37½ parts of aromatic oil), PLIOFLEX 1712C (cold, staining SBR, extended with 37½ parts highly aromatic oil), and PLIOFLEX 1714C (cold, staining SBR, extended with 50 parts highly aromatic oil)—to serve as better stabilization building blocks.

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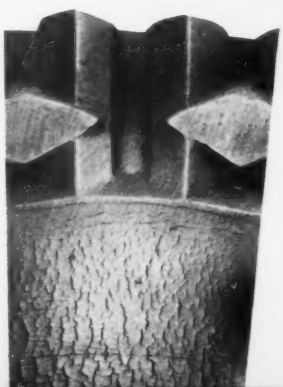
OVER-THE-ROAD TEST
Akron, Ohio—14,000 miles

Tire protected with WING-STAY 100
vs.
Tire containing equal parts of competitive antioxidant



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7. Lower power requirements

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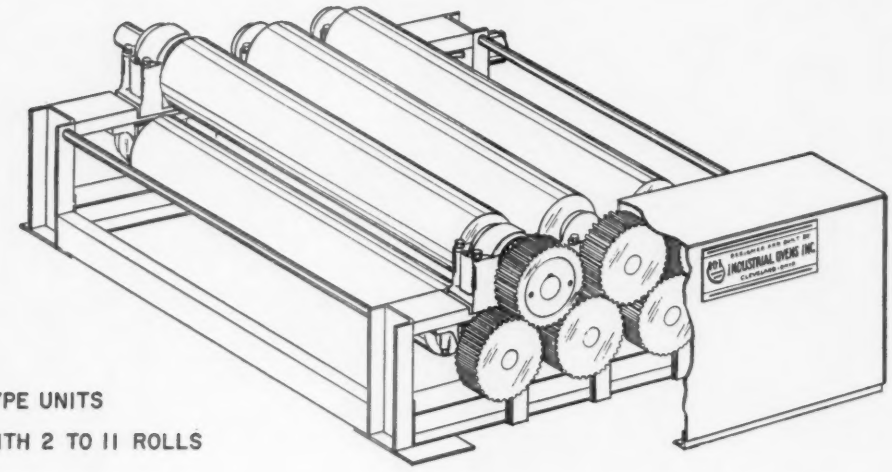
TIRE FABRIC PROCESSING EQUIPMENT

PULL ROLLS



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DESIGNED WITH 2 TO 11 ROLLS

CAPABLE OF EXERTING TENSIONS
UP TO 30,000#
DESIGNED FOR MAXIMUM DEFLECTION OF .010"

SUITABLE FOR WET OR DRY MATERIAL
ROLLS OF DIFFERENT MATERIALS AND FINISHES
MADE TO SUIT YOUR REQUIREMENTS

MANY SATISFIED CUSTOMERS
CAN CONFIRM THE RUGGEDNESS
& DURABILITY OF OUR PULL ROLLS
UNDER CONTINUOUS SERVICE.

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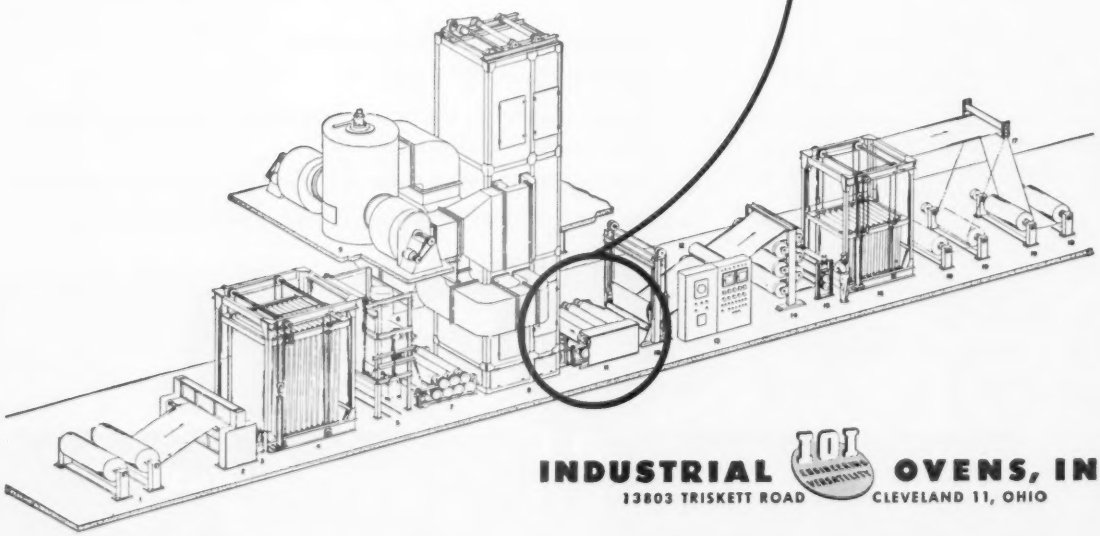

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Piccopale @ 20°C—0.975

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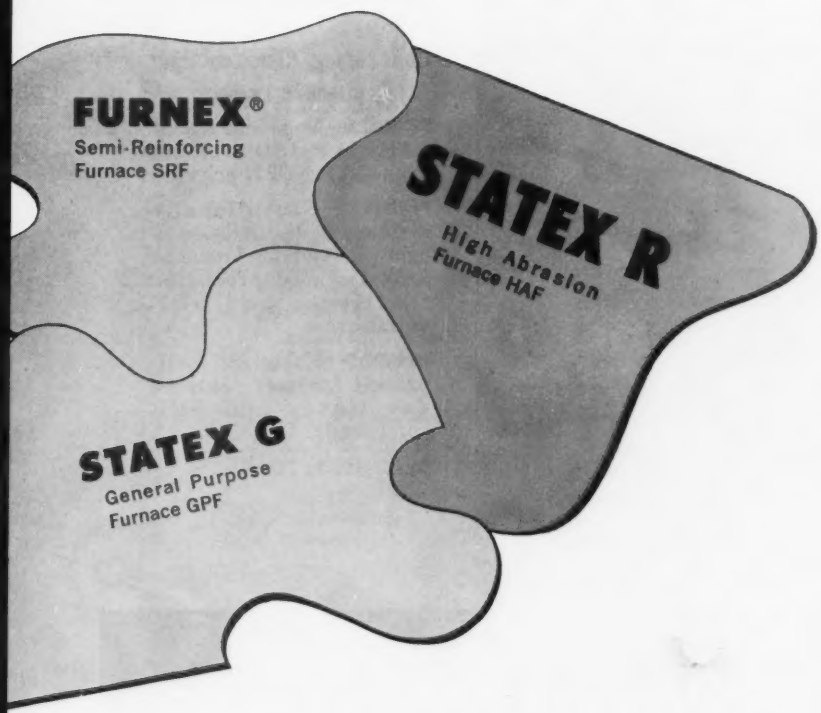
STATEX 93
High Modulus Furnace HMF



COLUMBIAN has a carbon black to fit your every rubber need!

From the outstanding blacks of the STATEX range to the new NEOTEX blacks — those oil furnace carbon blacks that provide a softer ride, less noise, good wear — Columbian has a carbon black for every use. Contact your Columbian representative . . . and send off the coupon for complete information, today.

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Tell me more
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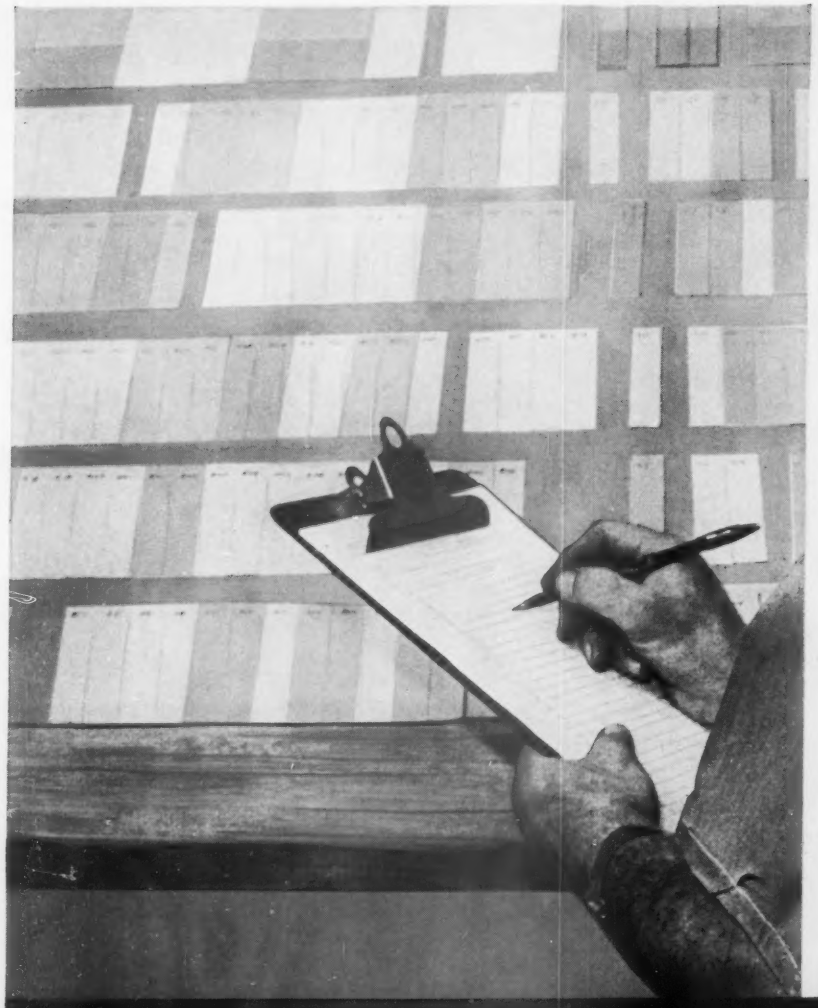

THE PENNOX SERIES

General purpose amine-type

PENNOX A—Slightly discoloring amine-type antioxidant effective in both dry rubber and latex. Provides good high temperature aging in latex.

Nonstaining, nondiscoloring phenolic types

PENNOX B—Good antioxidant for Hevea and SBR vulcanizates and raw SBR polymer.

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For effective age resistance Pennox Antioxidants

In the Pennox series you'll find a dependable age resister suitable for most rubber compounding situations. Pennox antioxidants protect Hevea and SBR vulcanizates, raw SBR polymer, and latex products from the deteriorating effects of heat and oxidizers . . . also provide superior gas fading protection for latex, and minimize discoloring of fabrics coated or used in contact with latex products.

For detailed information on the Pennox series, write or ask your Pennsalt representative for Bulletin S-151, Pennox Antioxidants; and Bulletin S-152, Pennox Antioxidants for Latex. Evaluation samples available on request.

Pennox is a trade name of Pennsalt Chemicals Corp.

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For The
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Direct Reporting On Baird-Atomic Spectrometer

RUBBER GRADE — FAST CURING TYPES

BLACK LABEL No. 20

Very fine particle size, giving maximum reinforcement and activation in rubber. For highest quality rubber goods.

RED LABEL No. 30

Excellent reinforcing and activating properties in rubber. Having fewer extremely fine particles, it is easier to incorporate than Black Label No. 20.

RUBBER GRADE — SLOW CURING TYPES

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RUBBER GRADE — SURFACE TREATED TYPES

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These grades are made from Black Label No. 20 and Green Label No. 42, respectively, by surface treating with a nontoxic hydrophobic high molecular weight organic material. They disperse in a rubber mix rapidly and thoroughly, developing physical properties, in vulcanized rubber comparable to standard Black Label No. 20 and Green Label No. 42.

LATEX GRADE

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Very fine particle size, giving minimum settling out in water dispersions and maximum activation in Latex Compounds.

GREEN LABEL No. 12

Heavily-calcined Black Label No. 20 type, containing few extremely fine particles. Less reactive than Black Label No. 20 and produces low viscosity water dispersions which do not readily thicken.

GREEN LABEL No. 43

Medium particle size for easy wetting. In pellet form this grade is particularly advantageous in preparing pourable 70% zinc oxide water dispersions.

GREEN LABEL No. 42

General purpose type. Excellent activating and moderate reinforcing properties. Faster rate of incorporation into rubber than Black Label No. 20 or Red Label No. 30.

GREEN LABEL No. 43

Large particle size type for easy incorporation. Good activating and reinforcing properties.

GREEN LABEL No. 42A-3

Somewhat larger in particle size than Red Label No. 31 for easier incorporation; otherwise, similar in general characteristics.

GREEN LABEL No. 46

Low pH type used in foam latex where zinc oxide is used for both activation and as a supplementary gelling agent.

RED LABEL No. 30

Intermediate particle size, having fewer extremely fine particles than Black Label No. 20. Less reactive than Black Label No. 20, producing lower viscosity water dispersions which do not readily thicken.

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ZNO-158

as revealed in the new ASRC manual*

ASRC 3106 offers you a BIG 9% SAVINGS!

ASRC 3106... unlike other general purpose type polymers, has an appreciably lower ash content and consequent low-moisture absorption qualities. If you have been using high-priced, low-ash polymers to compound products with medium moisture absorption requirements, ASRC 3106—priced at least 2¢ less per pound—can provide welcome savings on material costs.

SEE HOW

ASRC's General Purpose Type Polymer No. 3106 satisfies non-critical moisture absorption requirements.

SPECIFICATIONS	Minimum	Maximum	Typical	Test Methods ASTM: D1416-58aT Section
1. Volatile Matter	—	0.75%	0.25%	3-6
2. Total Ash	—	0.35%	0.20%	11-15
3. Organic Acid (Stearic)	4.75%	6.75%	5.75%	30-35
4. Free Soap	—	0.50%	0.05%	36-40
5. Bound Styrene	22.5%	24.5%	24.0%	25-29
6. Viscosity, Raw Polymer ML 212 F @ 4 minutes	46	56	50	ASTM D927-57T
7. Viscosity, Compounded ML 212 F @ 4 minutes	—	70	60	

One of Many Money-Saving Recipes with ASRC 3106!

MEDIUM HEAT RESISTANT STOCK	
ASRC 3106	100
Cumar EX	10
Titanium dioxide	10
Zinc oxide	20
Stearic acid	1.25
Sunproof wax	3.5
Hard clay	100
Agerite Stalite	1.5
Benzothiazyl disulfide	2.5
Methyl zimate	1.25
Sulfur	2
	252.00
Properties:	
Durometer, Shore A	70
Tensile strength, psi	2000
Elongation, %	850

ARE YOU processing products such as: electrical blankets, mechanical cover stocks, wringer rolls, athletic goods, medium heat resistant stocks, tape cement, electrical pads, hospital sheeting, electrical parts, gaskets, for which ASRC 3106 is ideally suited? If so, ask your ASRC man to show how ASRC 3106 can become a real money-saver for you, too. *Call him today!*

**ASRC 3106 is one of many polymers described in ASRC's new desk-side manual. Containing complete specifications on all ASRC synthetic rubbers, it is handsomely designed in an indexed, loose-leaf format. A significant addition to your technical reference library . . . the manual makes synthetic rubber selection easy as ASRC. FREE to compounders; write for your copy—on your company letterhead, please.*

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THE FIRST NAME IN SYNTHETIC RUBBER

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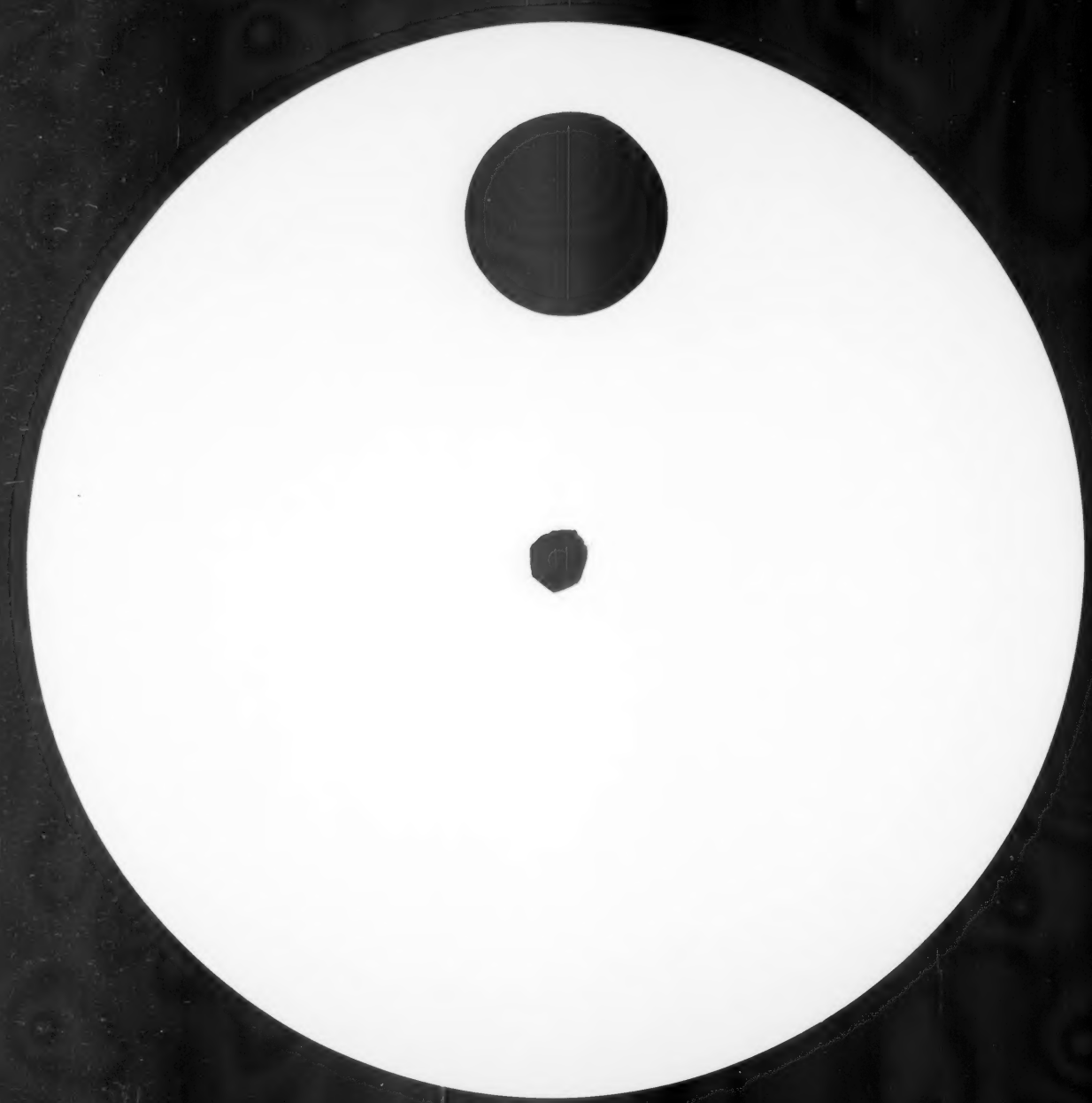
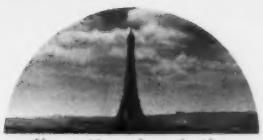
Cabot carbon black
serves the rubber industry
the wide world over



WHEREVER TIRES ROLL...

Cabot carbon black serves the rubber industry the wide world over



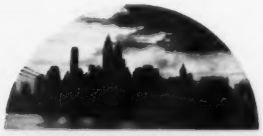
No matter where in the world you are, Cabot can serve you better.

Cabot has sales representatives in all principal cities of the world. *Call your nearest Cabot man today.*

Cabot produces more different grades of carbon black than anyone else.

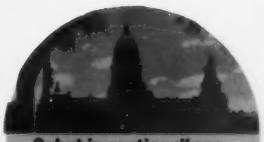
Cabot ships carbon black from more countries, sells in more currencies.

Cabot sells more carbon black than anyone else in the world.

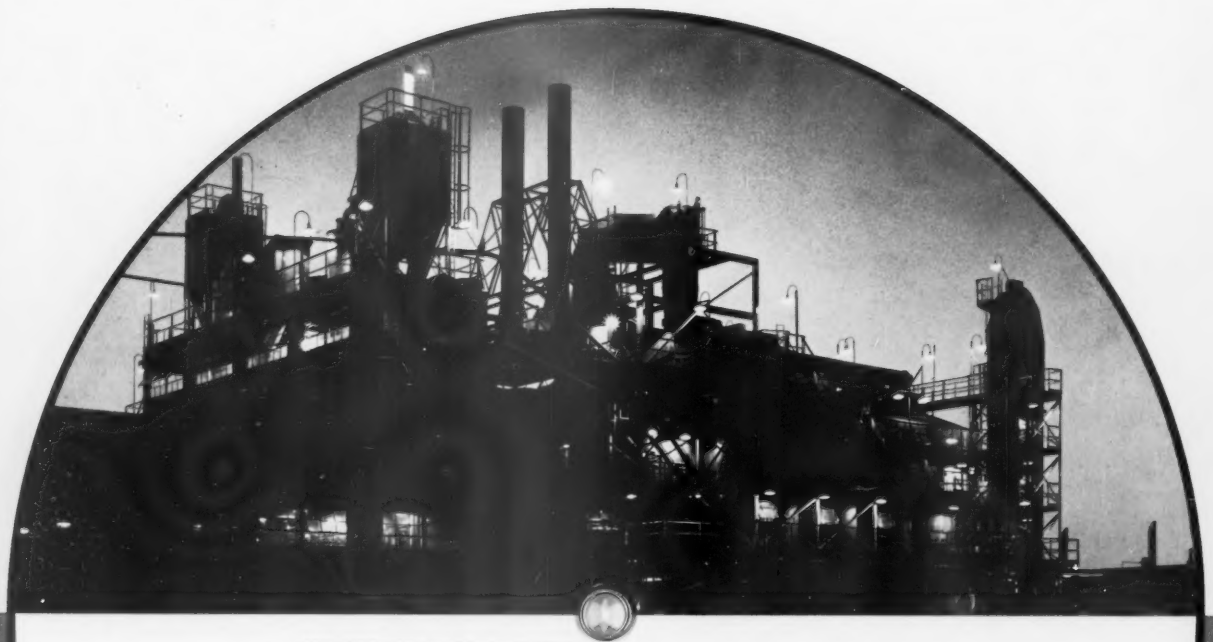


Cabot carbon black is sold on all 6 continents. In 58 different countries.

Cabot has more oil furnace black plants world-wide than anyone else.



Cabot is continually establishing new plants both at home and abroad.



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Cabot Europa, 45, rue de Courcelles, Paris 8, France
Australian Carbon Black Pty. Limited, Millers Road, Altona, Victoria, Australia (jointly owned)

Printed in U.S.A. January 1961

The sole on the right. It was made with Du Pont "Ti-Pure" R-101, a rutile titanium dioxide pigment, while the other sole was compounded with an anatase TiO_2. R-101 offers tinctorial properties similar to anatase and has better dispersibility and opacity than conventional rutiles. ■ You need less R-101 to obtain the same degree of color and opacity offered by anatase. Result: savings up to 20% in pigment costs. On an equal cost basis, R-101 improves the optical properties of rubber goods over anatase. ■ Similarly, "Ti-Pure" R-101 offers a 5-10% savings over conventional rutiles in providing equivalent color and opacity in rubber floor coverings and plastics systems. Get all the facts about this versatile, cost-saving pigment from your Du Pont Pigments Representative, or write: Du Pont Company, Pigments Dept., Wilmington 98, Delaware. ■ In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

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titanium dioxide pigment

No loose black
No bulk oil
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assures savings in shipping, storage and handling

You can save many ways with Gentro-Jet, General Tire's steam-whipped SBR-carbon black masterbatch. Shipped on neat, easy-to-handle skids, Gentro-Jet takes less floor space and eliminates the problems of loose black, irregular bales of rubber and drums of oil stacked for use.

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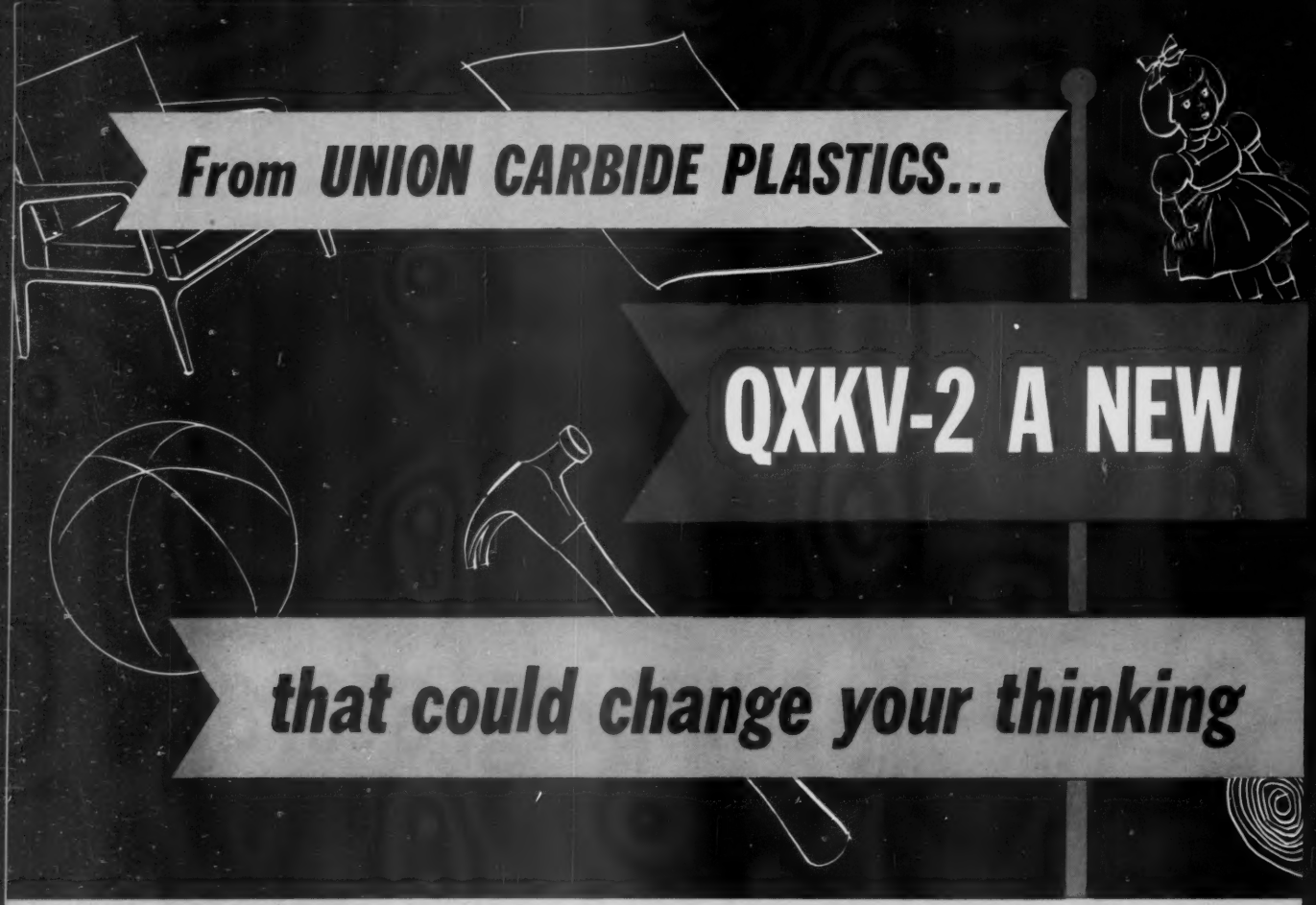


From UNION CARBIDE PLASTICS...

QXKV-2 A NEW

that could change your thinking

Here is a new vinyl chloride stir-in resin with truly exceptional properties! QXKV-2 has been designed especially for Plastisol–

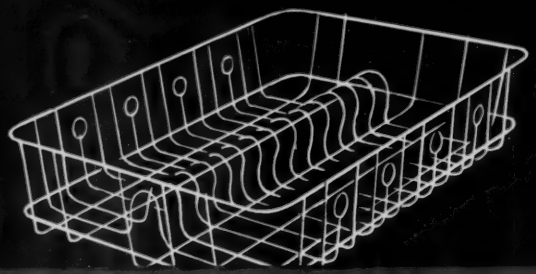
DIP COATINGS
SLUSH MOLDING
RIGID AND FLEXIBLE ROTATIONAL MOLDING
MACHINE-APPLIED COATINGS

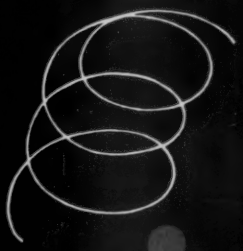
Dispersions based on QXKV-2 are outstanding in heavy non-sagging coatings...high structure at low shear rates... rapid gelation rates... good viscosity stability... good heat stability.

Plastisols made from QXKV-2 perform better than traditional materials and competitive types of resins currently available.

IMPROVE YOUR PRODUCT WITH QXKV-2 DISPERSION RESIN!

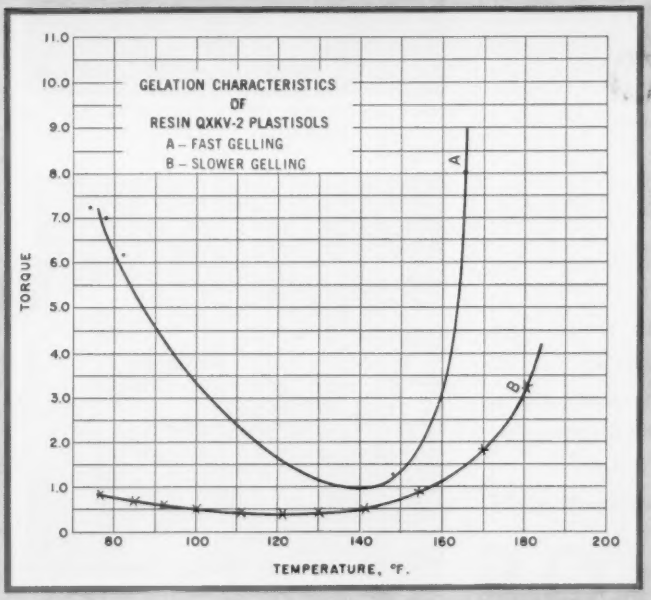
Plastisols formulated with QXKV-2 resin make economical, durable coatings for metal, paper, cloth, foil and wire. Vinyl dispersions are being used extensively in the manufacture of many products such as: toys, children's gloves, footwear, dish drainers, work gloves, tool handles, plating racks, elastomeric sealants and gasketing as well as many more. Now you can get the profit making advantages of a vinyl resin ... *without* changing your production set-up!





BAKELITE DISPERSION RESIN BRAND

about PLASTISOLS



Two examples of the gel rates obtainable with plastisols based on QXKV-2. Contact your formulator for a plastisol to meet your requirements.

FORMULATORS:

For the most authoritative information in vinyl dispersions, consult the originators of this technique! Write Dept. IC-87, Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

UNION CARBIDE

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"ROBOT BRAIN"

works faster, more precisely!

Taylor FLEX-O-TIMER® Controller gives:

- *Up to 12 pneumatic and/or electric functions*
- *Faster, easier setting of Program Trip Pins*
- *Positive acting air valves with more than 3 times previous output capacity*

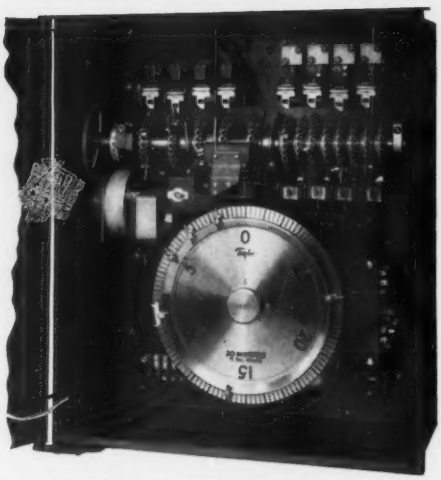
Recognized for many years as a highly versatile "robot brain" for the precise timing and coordination of batch processes, this new FLEX-O-TIMER Timed Program Controller has been made even more simple to operate, more precise in its control. It is ideal for providing completely automatic time control for tire presses, particularly for nylon cord tires requiring additional functions; platen presses; or any process requiring precise timing of process sequence and duration involving temperature, pressure, mechanical motion, electrical energy, or any combination thereof.

As well as the three major improvements listed above, the new FLEX-O-TIMER Controller incorporates these plus features:

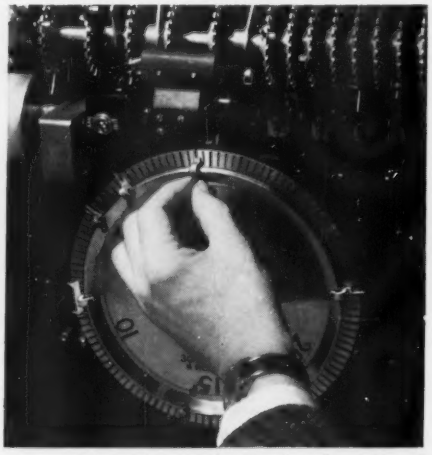
- Extremely short time intervals between steps (with high accuracy) can be accommodated . . . 7½ seconds on 30 minute cycle dial; minimums on other dials in same ratio.
- Cycle range is quickly adjustable for 15 to 60 minutes for highspeed range. 1 to 16 hours for low-speed range.
- Time dial automatically resets to zero in maximum of 13 seconds at completion of cycle.

* * *

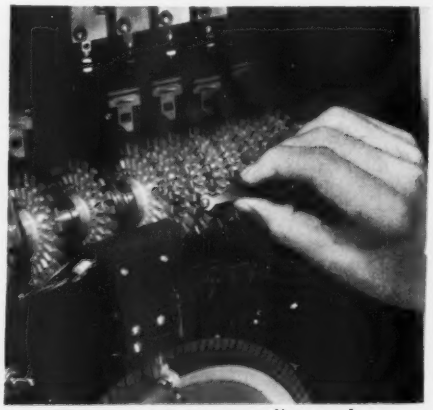
Ask your Taylor Field Engineer for full details or write for **Bulletin 98373.**
Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ont.



The 350R Series FLEX-O-TIMER Timed Program Controlled actuates switches, valves, performs other operations at the proper time and in proper sequence.



Program Trip Pins are simply placed at selected intervals, set screws tightened with an Allen wrench.



Step Cams fit snugly into step disc notches, are easily bolted into place, never have to be adjusted.

Taylor Instruments **MEAN ACCURACY FIRST**

AT LAST!

A <u>Better</u> Sulphur at a Competitive Price
Pay No More
Get a Better Product

ROYAL SULPHUR

QUALITY
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PRODUCTS

Now you can offer your customers a better product at no increase in cost, due to the use of this superior vulcanizing agent. ROYAL will grind to your specifications and provide "treated" or "untreated" Sulphur. ROYAL gives a higher Sulphur content and more brightness. NO EXTRA COST.

Write for further information and sample

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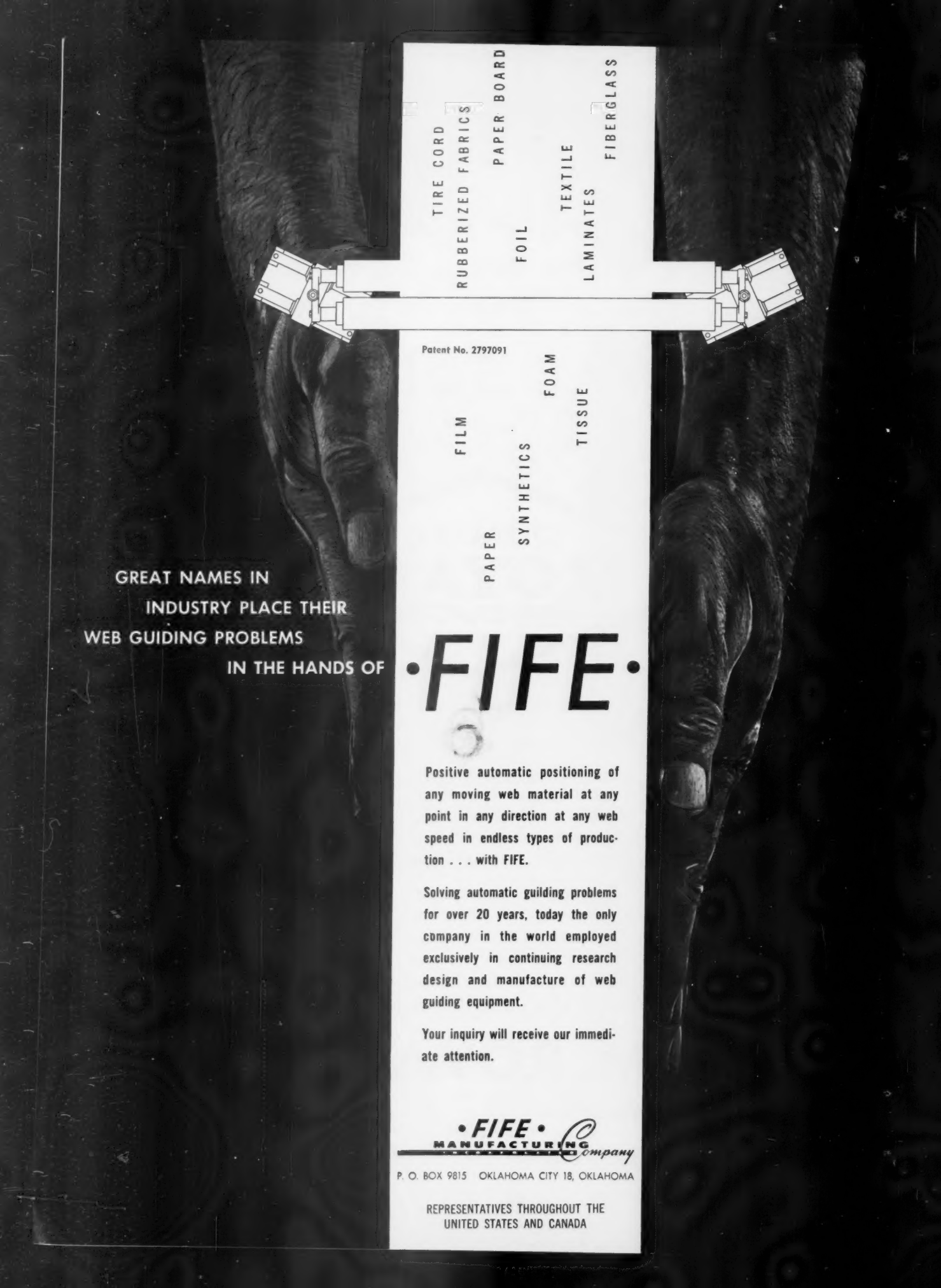

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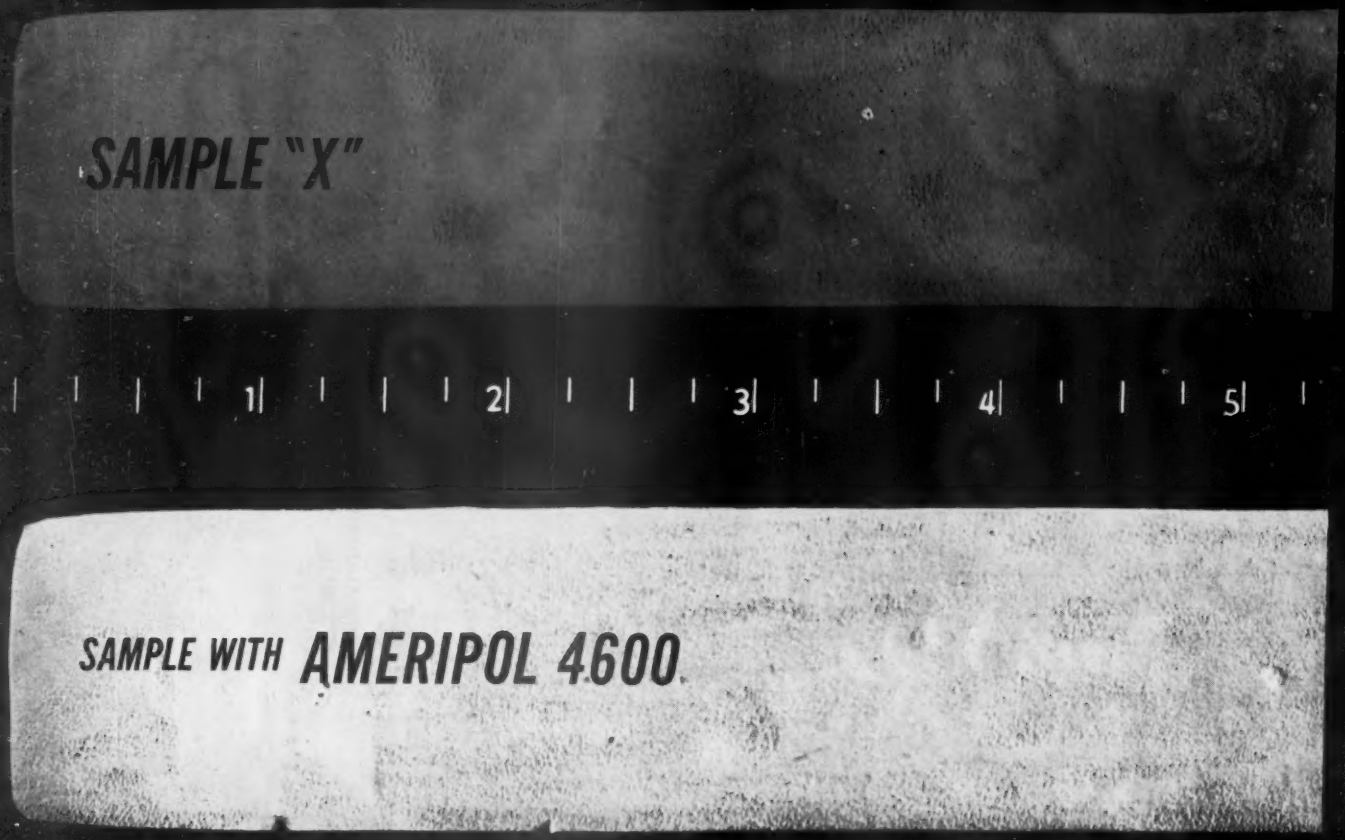
Ameripol Rubber takes to color, like a duck...

The manufacturers of these various rubber products leave color masterbatch compounding to an expert: Disco, Incorporated, of Butler, New Jersey. Disco uses an Ameripol rubber polymer from Goodrich-Gulf since experience has shown its exceptional uniformity, and excellent dispersion characteristics. This simplifies color compounding—and with pigments costing up to 30 dollars a pound, variations can't be tolerated. In addition, Goodrich-Gulf service ... in convenient warehousing, dependable delivery, and technical assistance, contributes to an efficient operation. For complete service, come to the world's largest source of synthetic rubber. Goodrich-Gulf Chemicals, Inc., 1717 East 9th Street, Cleveland 14, Ohio.

Ameripol
THE PREFERRED RUBBER

Goodrich-Gulf Chemicals, Inc.

THE ONE TO WATCH FOR NEW DEVELOPMENTS



Ameripol 4600 "Yields" more in sponge recipe

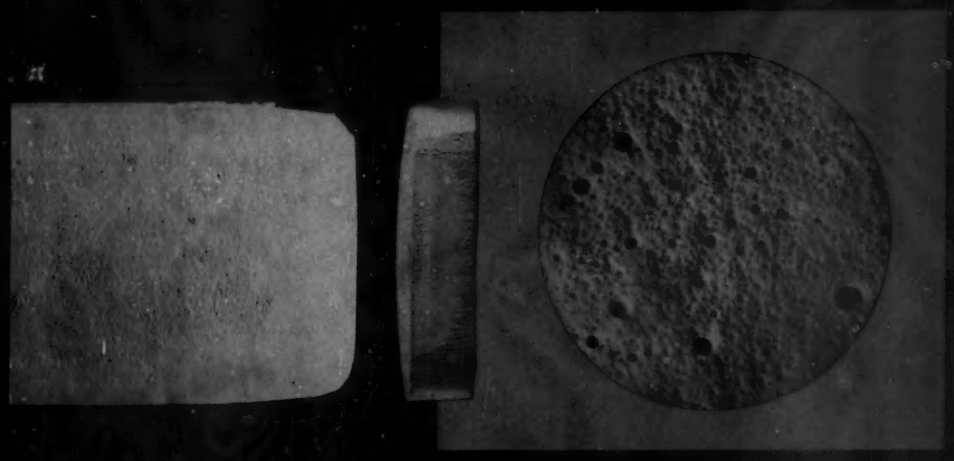
The test strips above show how the Goodrich-Gulf Technical Service Laboratory was able to help a producer of closed-cell sponge shoe soles improve his product.

The customer sent for evaluation a sample of the stock he was using. This stock was not giving the desired cell structure. Weight and density of the finished article were too high. This material is Sample "X"... a blend of a 1703 type of SBR and natural rubber.

A recommended highly loaded recipe using Ameripol 4600 proved superior, as shown by the samples above. Note the more uniform, open cell structure with Ameripol 4600. And the 4600 sample is larger in dimensions. With reduced density, the "Yield" or volume of sponge stock per pound of raw materials was increased.

These qualitative improvements were realized at a considerable savings. Use of the recipe with 4600

Ameripol
THE PREFERRED RUBBER



COMPARISON OF SAMPLES

	Sample with Ameripol 4600
Cost per pound	$ .1880
Cost on a pound/volume basis	.0987
Defo Hardness	2250 gm.
Per cent recovery	97.7%

...has better cell structure, too!

cut cost from 16.3 to 9.8¢ on a pound/volume basis.

These results show the advantages of working with Goodrich-Gulf on your rubber needs. Since we produce the broadest range of SBR polymers, we have a wealth of technical data and know-how to share. And our Technical Service Group is ready to help. Put Goodrich-Gulf to work on your team!

RECIPE USING AMERIPOL 4600

Recipe phr	Parts
Ameripol 4600	100
Goodrite 2007	20
RPA #6	0.5
Zinc oxide	5
Aquarex NS	1.75
Titanium dioxide	10
Hard clay	60
Silene EF	20
Agerite Superlite	2
Aktone	2.9
L. P. Circo Oil	10
Unicel ND	8
Petrolatum	3
Altax	1
Sulfur	3
Total	**247.15**

The stocks (0.25 inch slabs) were cured in a Ross flex mold for 8 minutes at 307°F. (confined), followed by 10 minutes at 307°F. (unconfined), then aged 8 hours at 212°F. in a circulating air oven.

Methods for manufacture of closed cell sponge are covered by various U. S. and foreign patents; these should be checked and necessary licenses obtained before use of such processes.

Goodrich-Gulf Chemicals, Inc.

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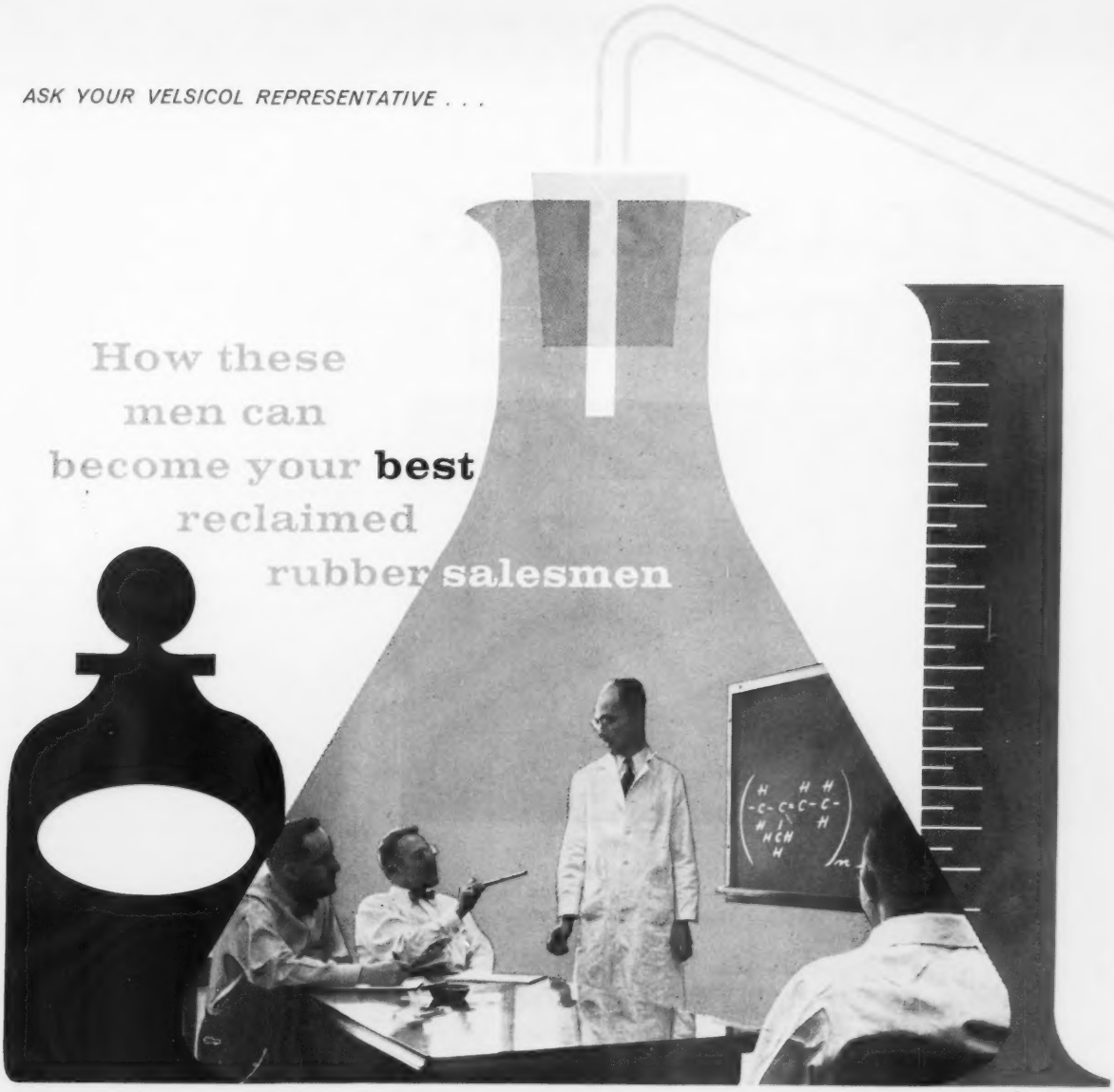

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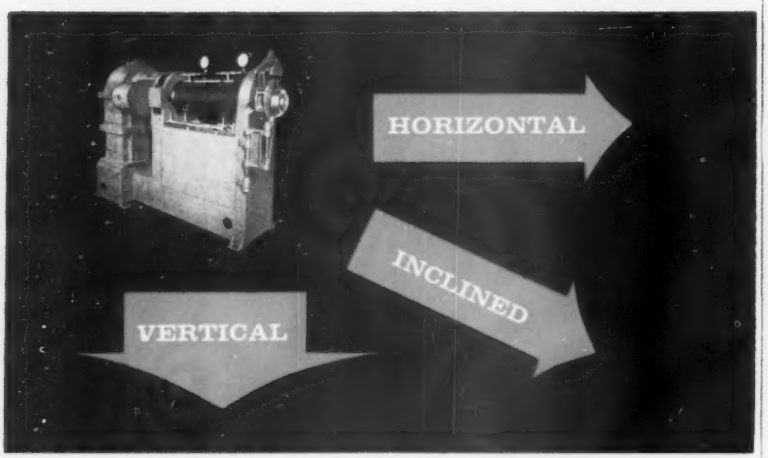

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News in Brief

▶ "Chemical Loaded Molecular Sieves," a booklet made available by the New Products Department, Linde Company, New York, N. Y., is divided into sections on the company's chemical-loaded molecular sieves, a case history, uses for the sieves, and an inquiry form for requesting further information.

▶ Hycar Latex Newsletter No. 18, which can be obtained from the B. F. Goodrich Chemical Co., Cleveland, Ohio, describes the general properties of Hycar latices and contains general and specific compounding information designed to be of use to both present and prospective users of these materials.

▶ The August-September 1959 issue of "News about Du Pont Elastomers and Chemicals," made available by the Elastomer Chemicals Department of E. I. du Pont de Nemours and Co., Inc., Wilmington, Del., contains information on a new viscosity grade of Neoprene Type W, as well as news about neoprene, Hypalon, and Viton.

▶ A color, loose-leaf cover entitled "Technical Service," built to accommodate the company's technical information sheets and containing a numerical index, has been introduced by the Enjay Company, Inc., New York, N. Y.

▶ Bonding of rubber-to-metal with Ty-Ply adhesives is covered in Adhesives Bulletin No. 1A, made available by the Marbon Chemical Co., Washington, West Va. The booklet explains the various Ty-Ply types, general and detailed methods of use, bond characteristics and tie cements.

▶ Chemigum N600 pigmentation studies evaluating ten black and five non-black fillers are presented in Tech Book Fact CG-41, made available by the Chemical Division of the Goodyear Tire and Rubber Co., Akron, Ohio.

▶ "Tenite Plastic Views," published by Eastman Chemical Products, Inc., Kingsport, Tenn., is a 16-page booklet on vacuum forming butyrate, acetate, propionate and polyethylene Tenite plastics. Illustrations of various product uses are included, as is a note on the history of vacuum forming and a listing of Tenite sales offices.

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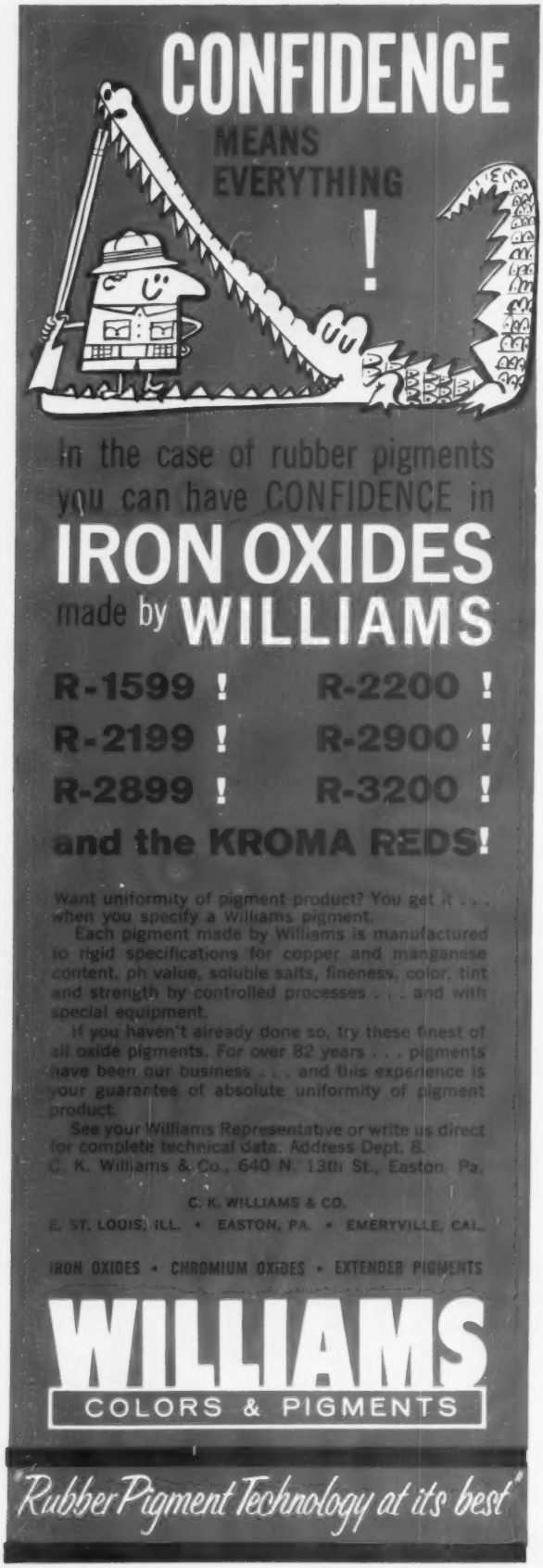
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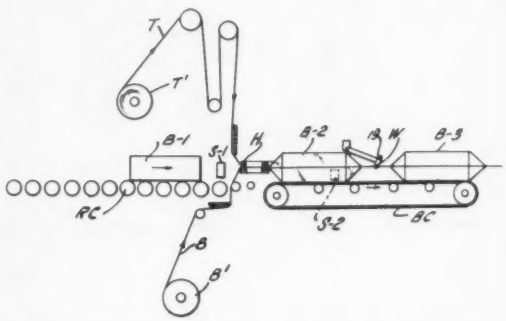
PATENT REVIEW

by Melvin Nord

Wrapping a Tacky Synthetic Rubber Polymer

U. S. Patent 2,931,148, issued April 5, 1960 to Andrew M. Smith and assigned to Texas-U.S. Chemical Co., describes a method and apparatus for wrapping tacky synthetic rubber polymer bales as shipping packages. The cold-flow process is anticipated by packaging the raw rubber in polyethylene film, having sufficient space on all sides in the resulting receptacle for plastic movement of the rubber without breaking the enclosing film.



The illustration shows the apparatus used to prepare this package. A bale (B-1) dropping from the bale press and passing along a conveyor system, reaches the rollers of the motor driven roller conveyor (RC) of the bale wrapper, and moves along to contact a first switch (S-1). After contact is made, the belt conveyor (BC) is actuated to move the bale into position (shown as B-2) for the sealing of the top and bottom sheets or films of polyethylene (T and B). This position of the bale is determined when the bale contacts a second switch (S-2) which stops the movement of both the roller and belt conveyors. A time-cycle controller (not shown) then regulates the sealing operation and mechanism. This brings the heating means and backing member together to seal the two sides and the upstream end of the envelope (enclosing B-2) and completes the package, since the downstream end had been sealed in the previous cycle. This operation can be seen where the downstream end of the envelope for the bale (B-1) is being sealed (H) while the envelope (B-2) is being sealed along its sides and upstream end. At the same time, a hot cutting wire (W) makes contact with the double thickness of polyethylene film to cut free the previously packaged bale (B-3). At the end of the heating cycle, the sealing device returns to open position, and the power circuits are energized for actuating the roller and belt conveyors

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PATENT REVIEW

(RC and BC). If no bale has yet reached the roller conveyor, the sealed envelope containing the bale (B-2) remains in position joined to the sheets of polyethylene. This bale may be removed manually, if desired, by cutting it free, and more usually, it is moved automatically when the first switch (S-1) is contacted to actuate the belt conveyor, which moves the completed package (B-2) into another area (B-3).

Stable Butyl Rubber Latices

U.S. Patent 2,936,295, issued May 10, 1960 to Robert S. Brodkey and Alfred L. Miller, assigned to Esso Research & Engineering Co., provides a method of preparing a highly stable butyl latex by emulsifying butyl rubber with an organic sulfate containing one or more ethylene oxide units. "Stability," "freeze-thaw," mechanical, and processing stability, mean that the emulsifier has the general formula:

$$R(OCH_2CH_2)_nOSO_3X$$

where R is aliphatic aryl, alkaryl, or cyclic, n is 1 to 9, and X is a monovalent metal or radical. It has been found also that stability is increased further by adding small quantities of a monovalent salt of an ortho phosphate during the homogenization step.

Preserving Freshly Harvested Rubber Latex

U.S. Patent 2,932,678, issued April 12, 1960, to Kalyanaramaiyer C. Sekaran and John E. Morris assigned to the British Rubber Producers' Research Association, describes a process for preserving freshly harvested rubber latex from the Hevea brasiliensis tree. About 0.3-0.4 per cent by weight of ammonia is added to the latex within 12 hours of obtaining the latex from the tree. The ammoniated latex is centrifuged to a dry rubber content of about 60 per cent by weight within about 36 hours after obtaining the latex from the tree. Ammonia is then added to the concentrated latex to increase the ammonia content to about 0.2 per cent by weight of the latex. Immediately, 0.1-0.3 per cent by weight of boric acid is added to the ammoniated concentrated latex.

Tubeless Tire

U. S. Patent 2,934,126, issued April 26, 1960 to Matthew W. Wilson and assigned to B. F. Goodrich Co., discloses a non-wicking fabric adapted for use in a tubeless vehicle tire. It consists of interconnected multiple-filament cords of water-insoluble nylon, with the interstices between the filaments of each cord blocked to the passage of air by water-soluble nylon deposited in the interstices.

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PATENT REVIEW

Tire Casing Package

U. S. Patent 2,928,540, issued March 15, 1960 to Marion M. Cunningham and assigned to United States Rubber Co., provides an inflatable bag for facilitating the handling of tubeless tire casings. While in a collapsed or partially collapsed condition, the inflatable bag is inserted through the openings of the stacked tire casings until the bag end rests on the same base as the stacked tires. Then the bag is inflated. When expanded, it tightly grips the inner surfaces of the beads of the tire casings. The tire casings are secured together and it is now possible to handle them as a unit.

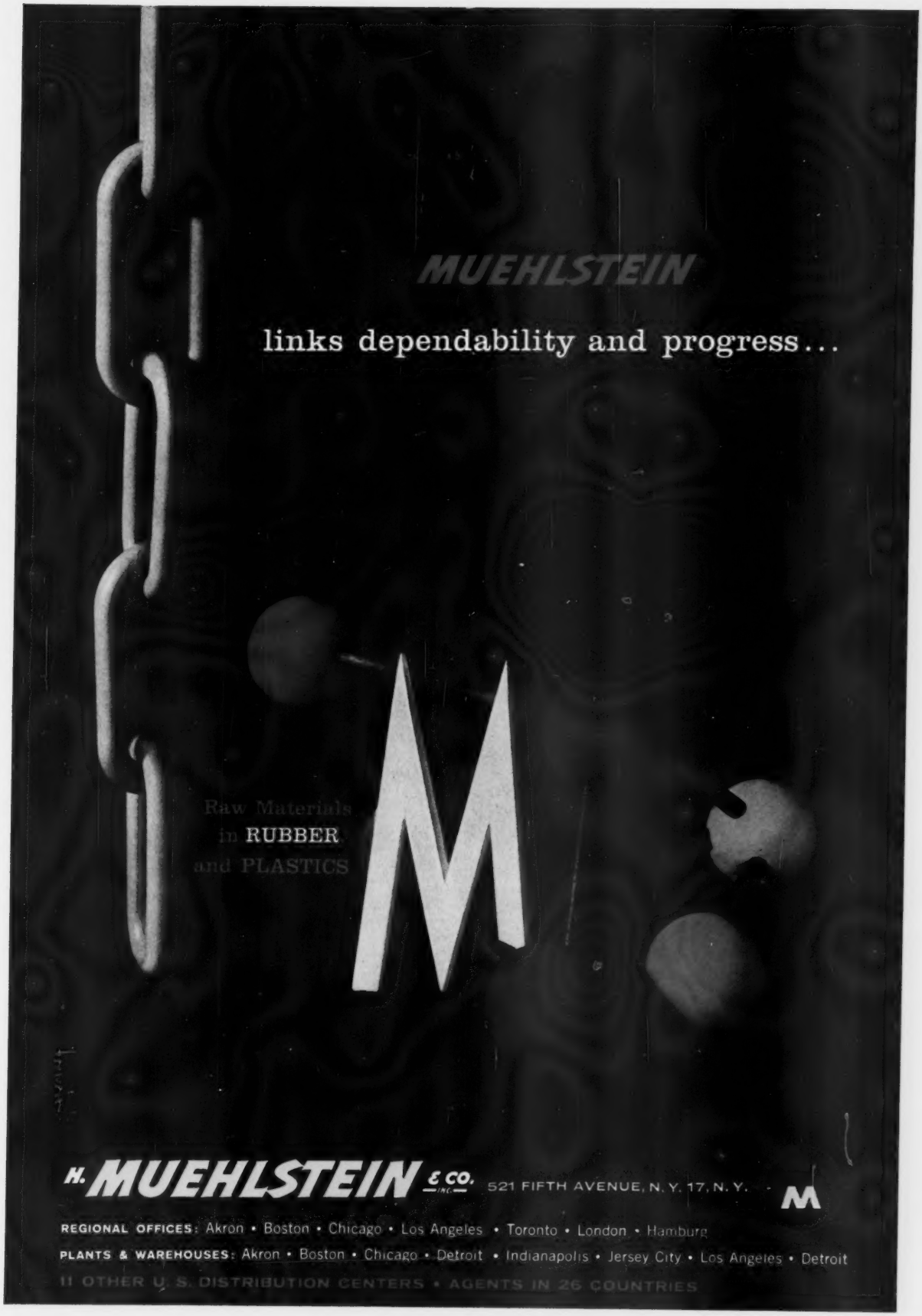
Molding Foam Latex Strips

U. S. Patent 2,931,063, issued April 5, 1960 to Edward P. Harris, assigned to General Motors Corp., provides an apparatus for continuously molding foam latex strips. The method allows progressive filling of an open moving mold cavity with a flowable, moldable material to a predetermined depth and maintaining an attaching means for the strip in position in the filled open mold cavity so that the strip thus continuously formed may have an attaching means secured in it.

Other Patents of Interest

Subject	Inventor or Assignee	Patent No.	Date
Machine for building tires	Carlisle Corp.	2,931,420	4/5/60
Vulcanizable composition	Universal Oil Products Co.	2,932,622	4/12/60
Tire capping apparatus	Louis T. Fike	2,932,853	4/19/60
Manufacture of roller assemblies	Dayton Rubber Co.	2,932,856	4/19/60
Treating fiber cords	General Tire & Rubber Co.	2,932,901	4/19/60
Tire	Esso Research & Engineering Co.	2,933,117	4/19/60
Tire	James W. Waber	2,933,118	4/19/60
Valve for tire	Firestone Tire & Rubber Co.	2,933,119–21	4/19/60
Apparatus for recapping tires	Arthur E. Richardson, et al	2,933,765	4/26/60
Steam hose	American Biltrite Rubber Co.	2,934,096	4/26/60
Dual-valved safety tire	Frank A. Howard	2,934,127	4/26/60

Copies of any patents, including those described here, are available from the Commissioner of Patents, Washington 25, D. C., for 25 cents each. Do not send stamps.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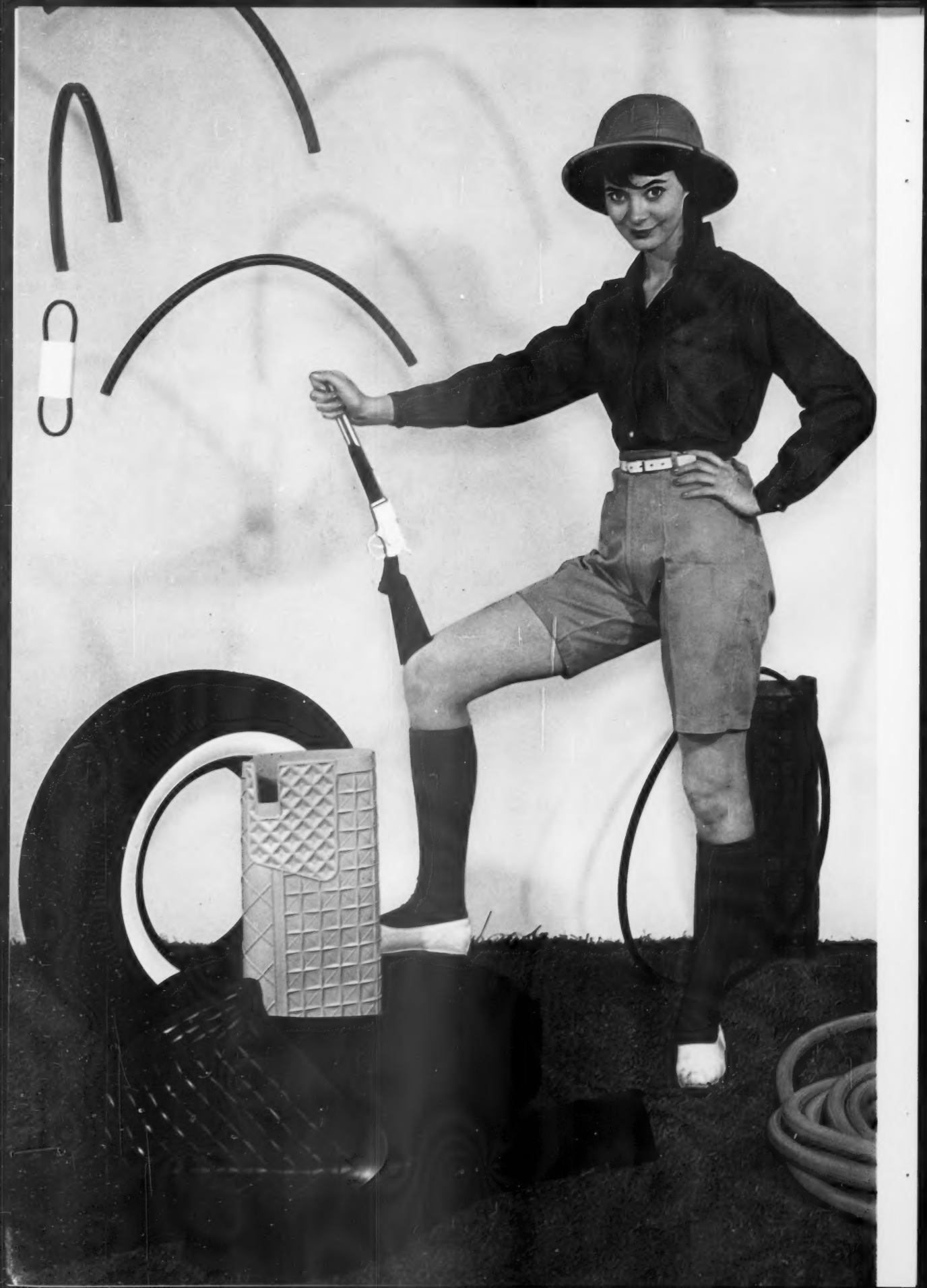

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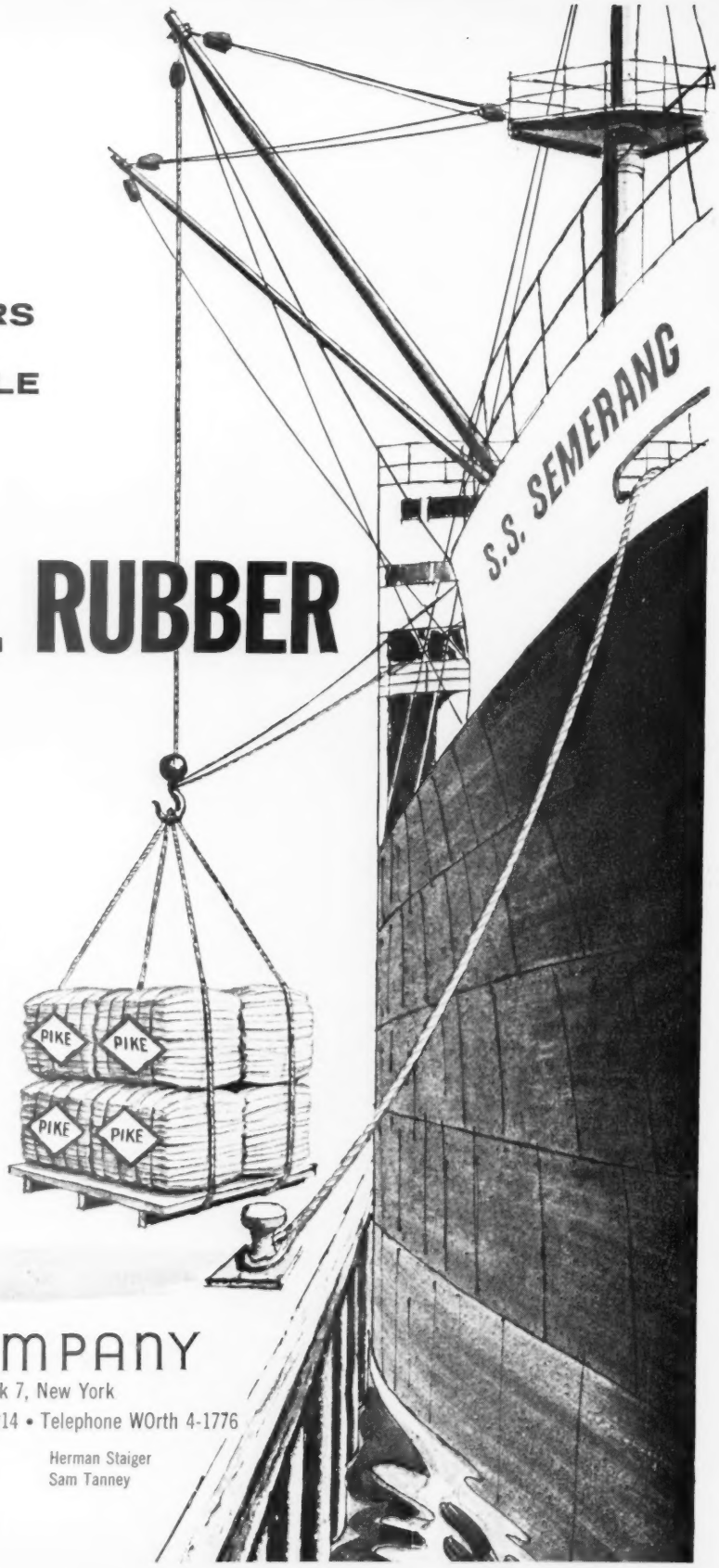

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As Ken Soule Sees It

by Kenneth J. Soule

High-Powered Handling

Installation or repair and service work on high-tension lines has always been fraught with the ever-present danger of electrocution, or, at least, serious burns. Linemen working on such highly charged wires, while their bodies were grounded due to contact with poles and towers, have therefore been forced to use bulky, cumbersome insulated tools in the course of their duties. Otherwise a moment of carelessness or inattention could be fatal. One net result has been that it has required an excessively long time to complete even comparatively simple repair jobs.

Fortunately for all concerned, a new method has been developed which gives promise of revolutionizing the method of handling "hot-wire" work. As outlined in *Time* (November 14) the novel procedure was developed by the American Electric Power Co., Inc., and is presently being used by them in their repair operations. In this method the lineman climbs into an open-end plastic box or bucket and is lifted to the area to be repaired by a fiber glass insulated boom. There he connects the high-tension wire to the metal mesh which lines his "bucket," by means of a cable. The immediate result of these steps is to charge the metal mesh thoroughly, and, incidentally, the body of the lineman in contact with it. However, since the workman is completely insulated from the ground by the fiber-glass boom, he can safely work on the wire with bare hands and simple metal tools. Naturally, the repair work proceeds much more quickly and efficiently than under the old set-up.

There seems to be only one "catch" to the new technique. Linemen employing it must, of necessity, remember *at all times* that they themselves are carrying the full charge of the wires with which they are working. Therefore, contact with *any* grounded object could, and probably would, be fatal. A new safety first angle which the high-tension workers will learn quickly, or not at all!

Conveying Belts

Industrial conveyor belts have a rather long and eminently satisfactory record in this country—and in fact, all over the world—as time and labor savers in many diverse applications. However, when the product being transported is human beings, the situation becomes quite unique and the previous history rather short.

One of the earliest passenger conveying belts was put in operation in Jersey City at the Hudson and Manhattan Railroad's Erie Station about six years ago. At the time of installation it attracted a great deal of attention, and the record of its performance has been carefully studied by other communities and other potential users. During the ensuing years similar belts have been utilized in many parts of the U.S. by a wide variety of sponsors. According to *The New York Herald Tribune*, the total number of such set-ups now is about fifty.

These include two in Chicago, one at Wrigley Field, and another in the rapid transit station at 63rd and Loomis Sts. In Los Angeles an auto-wash operator treats his customers to a free belt ride along the wash line, and in Little Rock, Ark., patrons of the city auditorium are similarly conveyed from the street level to the seating area. Other installations in Houston, Texas; Las Vegas, N.M.; Aberdeen, Wash.; and Atlanta, Ga.; provide their particular patrons with much the same sort of continuous transportation.

Meanwhile, Abroad

Great Britain, also, has the pressing problem of moving people horizontally, while they themselves stand upright. The newest and largest example of the British answer to this need is the "Travolator," a moving rubber-sidewalk recently put in operation in London. I am deeply indebted to S. W. McCune III and Richard T. Nye for furnishing data regarding its construction and operative details. Mr. McCune is a transplanted American, now serving as general manager of the DuPont Co. U.K. Ltd., while Mr. Nye is technical editor of *Rubber Journal and International Plastics*.

As I understand it, the Travolator installation consists essentially of two passenger conveyor belts, placed side by side. Each 624-foot length is spliced endlessly, and employs as drive members two lengths of Otis Elevator handrails—one on either side—also endless. In use, the twin moving platforms thus produced are about 312 feet long and have a top speed of 180 feet per minute. They can be set to move in either direction.

The two stations which the Travolator connects are *Waterloo*, one of British Railway's main line surface stations, and the *Bank*, which is the terminus of a near-by branch subway line.

Work on the massive project began in June, 1957, and has been proceeding more or less steadily ever since, in spite of a multitude of complications and interruptions. A booklet put out by the Southern

As Ken Soule Sees It (Cont'd)

Region of British Railways, describes some of the problems encountered and the major and minor difficulties met and overcome. These included the cramped working space, (limiting the "labour" force to 80-90 men), the necessity of working only at night, (7 pm to 7 am, with no pneumatic drills after 11 pm.), and, of course, the astronomical amounts of excavation, destruction, and ultimate construction until the all clear signal was finally achieved. From every angle, a great job, magnificently done!

Bowling and Progress (?)

New York City, and the countryside adjacent to it, is very well conditioned to the impact of the sport of bowling on its daily life. This is not surprising since through the years many New Yorkers have been more or less closely associated with bowling in at least one of its various forms. In fact, since Rip Van Winkle made fictional history in his famous meeting with the diminutive Dutchmen rolling nine pins high up in the Catskills, New York City has never been without its coterie of faithful bowlers. In the early days the action took place out of doors, chiefly on grassy slopes as is shown by street names such as "Bowling Green," which is still in existence today. Later, indoor alleys took over all along lower Broadway. Subsequently nine pins was supplanted by the present game.

Therefore, the furore occasioned by the announcement that tentative plans were being made to install a modern bowling center in New York City's Grand Central Station building was at first glance a bit unexpected. However, as the proposal was studied further, and the outcry against it considered objectively, there did seem to be considerable merit to the opposition claims.

For one thing, it would certainly appear that the heart of the noble town of Manhattan is not the best place in the world for a big, new, king-size bowling center. At least not as far as automobile traffic, parking, and other attendant evils are concerned. If the big town needs more alleys, (of the pin and ball variety), there must be better spots available than a revamped Grand Central Station.

And here we come to what is probably the crux of the antagonism to the suggested scheme. This involves the lowering of the ceiling of the Grand Central Station waiting room from the present 85 feet to 15 feet. The proposed alleys would be installed in all or part of the 70-foot space resulting. The purists, the as-is-ers, and the artists-at-heart, utter their loudest moans and their most anguished outcries at this alleged desecration. How, they say, can *anyone*—even the crassest materialist—consider for even a fleeting moment the destruction of the beautiful, the lovely, the noble, vaulted ceiling of the present station? And for what purpose? A bowling alley with ear-rattling thumps and raucous laughter resounding at all hours of the day and night!

I must confess that the thought of Grand Central's massive upper reaches reduced to midget proportions fills me also with a sense of claustrophobia. Granted a certain amount of commercialism is probably necessary in our modern world, it is also true that there *are* limits beyond which one *cannot* decently go, even in the hot pursuit of a fast buck. And the conversion of Grand Central, one of the world's great, majestic, stations for wayfarers from near and distant climes—from an area of wide-open spaciousness, to what by contrast would be in effect a crawl-space, seems to me to merit all the condemnation *anyone* cares to heap upon it!

Flexible Foams—Again

In the February, 1960, RUBBER AGE we had occasion to comment on the subject of the flexible foam "rubbers" available, and the types being chosen for large-scale consumption items. At that time there did not appear to be a clear-cut trend favoring either natural rubber, vinyls, butadiene-styrene polymers or polyurethanes, for furniture, mattresses, or various automotive uses. Actually, price seemed to be the largest factor in the final choice.

Now, at the beginning of a new year, it may be well to study what has taken place in the interim, and to note any present trends. As this is done, it seems difficult to note any major changes in the demand situation. Now, as previously, price appears to be a major factor in the choice between foams of nearly equal suitability. And, of course, during the past year, urethanes have been materially reduced in price.

However, in some cases, the adaptability or special properties of a given foam may dictate its use. For instance, John Quirt, writing in *The New York Herald Tribune,* quotes furniture manufacturers as prefering urethane foam for many of their needs, because it is "more durable and flexible." At any rate, they expect to consume at least 50,000 pounds of such foam in 1960—an increase of some 25 per cent over 1959. It is also said that this upward trend will continue in 1961.

For mattresses, and for automotive items such as arm rests and seat cushions, similar conditions appear to prevail. Polyurethane foam seems to be nibbling into the markets previously held by other types of cellular material. Here again, price is a large factor in the choice.

EUROPRENE*

SBR SYNTHETIC RUBBER

HOT TYPES	COLD TYPES	COLD OIL-EXTENDED TYPES
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1006	1502	1712
1009	1503	

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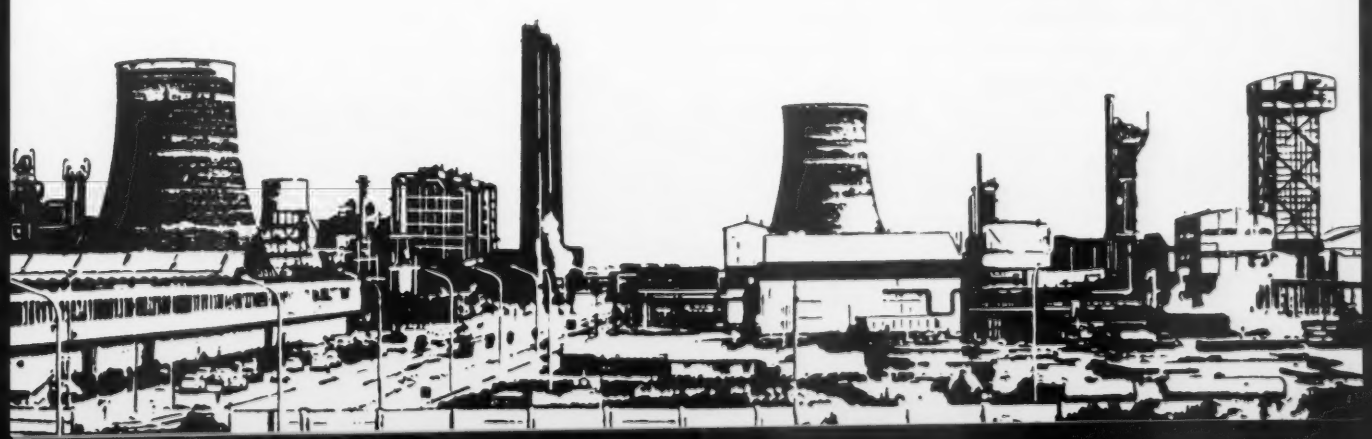
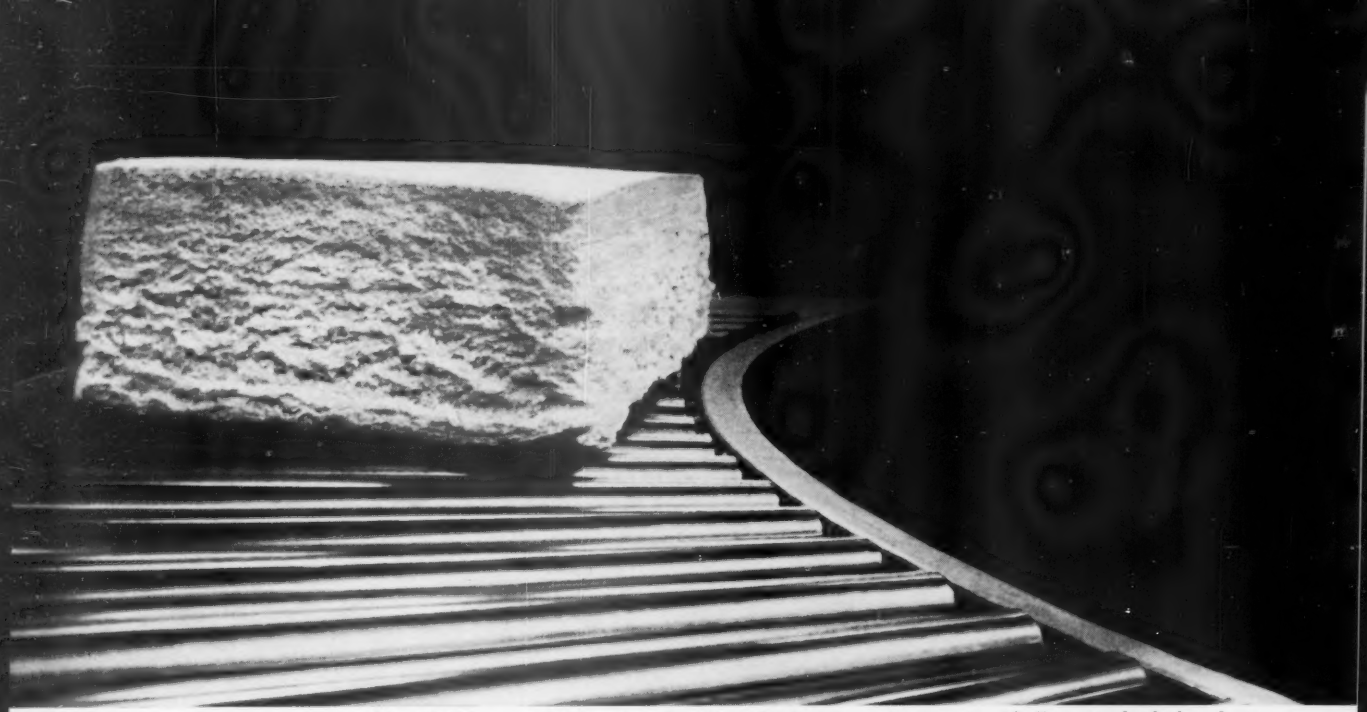
* TRADE-MARK





New Shell Isoprene Rubber. Note the white color. It accounts for exceptional brilliancy in finished products.

BULLETIN:

Shell Chemical announces increased production of polyisoprene—and tells how you can get immediate shipments of this revolutionary new rubber

Shell Chemical answers 16 questions about a new synthetic called Shell Isoprene Rubber. It is the first commercial polymer ever made that unites the advantages of natural and synthetic rubber.

Here is what manufacturers of truck and automotive tires, surgical tubing, toys, bathing caps, shoes, rubber bands and hundreds of other rubber products should know about new Shell Isoprene Rubber.

1. How new is Shell Isoprene Rubber? It is very new. For over 40 years chemists have struggled to reproduce the cis-polyisoprene structure of natural rubber. And produce a synthetic that could compete in price with natural rubber.

Laboratory success was first reported in 1955. Commercial success was reported by Shell in 1959. Since then, over 3,000,000 pounds of this remarkable new rubber have been sold to a wide variety of users.

2. Is Shell Isoprene Rubber the same as natural rubber? For all intents and purposes it is. Shell Isoprene Rubber is the first commercially made synthetic rubber to provide *high resilience* and *low heat build-up*. Its basic molecular structure is cis-polyisoprene—the same as natural rubber.

New Shell Isoprene Rubber can be used for applications that now require natural rubber. This includes such uses as heavy-duty truck tire treads, carcasses and sidewalls.

3. Does it have the advantages of synthetic rubber? Yes. Because Shell Isoprene Rubber is made by a chemically controlled process, it has the uniformity of synthetic rubber. New Shell Isoprene Rubber is readily available. And comes in easy-to-handle, 65-pound bales.

4. What color is Shell Isoprene Rubber? White. This unique whiteness accounts for the brilliancy that results when colors are added. Your customers will get better and brighter-looking products.

5. Can you be sure of uniformity? You certainly can. At Shell's Control Laboratories, specially trained professional technicians devote full time to the quality control of Shell Isoprene Rubber.

Samples are taken from tanks, lines and bales and subjected to rigid tests. The Shell Isoprene Rubber is com-

pounded, processed and cured to assure correct processing performance.

6. Does Shell Isoprene Rubber require different compounding ingredients than natural rubber? No. Shell Isoprene Rubber can be used with the same plasticizers, reinforcing agents, softeners, accelerators, vulcanizing ingredients and coloring agents as natural rubber.

Slight modifications of some formulations may be required to obtain optimum properties.

7. Can Shell Isoprene Rubber be processed in conventional equipment? Yes. Its processing characteristics, compounding formulations and vulcanization techniques are all similar to those of natural rubber.

Shell Isoprene Rubber is also compatible with natural rubber and most synthetic polymers and can be blended with them in any proportion.

New Shell Isoprene Rubber requires less mastication than natural rubber and it can be chemically plasticized at a faster rate. If it is subjected to the same breakdown as natural rubber, Shell Isoprene Rubber will become too soft for practical use.

Caution should be exercised when chemical plasticizers are used. They have a more rapid action with new Shell Isoprene Rubber than with other elastomers.

8. How does Shell Isoprene Rubber handle on the mill? It can be handled on the mill without pre-breakdown. When a smooth rolling bank is attained, compounding ingredients can be added in the normal way.

9. How about mold flow? New Shell Isoprene Rubber is superior to natural rubber in mold flow. This allows for better and more complete fill in intricate molds, finer detailing and increased production as a result of fewer rejects.

10. What can you make with Shell Isoprene Rubber? Since its initial introduction for commercial evaluation, manufacturers have discovered that Shell Isoprene Rubber's high resiliency, low heat build-up, color, uniformity, purity, mold flow and ease of processing make it ideal for hundreds of applications. Here are just a few:

Heavy-duty truck tire treads, carcasses and sidewalls, automobile bushings, motor mounts, protective bumpers, windshield wipers, surgical tubing, intravenous feeding tube connectors, crutch tips, toys, rubber thread, swim fins, bathing caps, instrument bellows, telephone ear pieces, electrical connectors, wire and cable insulation, shoe heels and soles and rubber bands.

Its future applications are unlimited.

How to get Shell Isoprene Rubber

To order, call your nearest Shell Chemical sales office. They are located in New York, Cleveland, Ohio and Lakewood, California.

Shell Isoprene Rubber and many of the more popular SBR types are stocked at the eight Shell warehouses in the cities shown above.

11. Can you get technical assistance from Shell? Yes. In addition to Research and Control Laboratories, Shell Chemical maintains a complete Technical Service Laboratory at Torrance, California. Both laboratory and in-plant assistance are available.

12. How much Shell Isoprene Rubber will be made? Shell's newly enlarged facilities at Torrance can produce 40,000,000 pounds of Shell Isoprene Rubber a year.

A second Shell Chemical plant with an annual capacity of 80,000,000 pounds is now under construction at Marietta, Ohio. This new plant is expected to be on stream late in 1961.

13. How about availability? New Shell Isoprene Rubber is now available in carload lots from Torrance. Shell Chemical can fill your order immediately.

For less than carload lots, Shell Isoprene Rubber is available from eight Shell Chemical warehouses. Their locations are: Boston, Trenton, Baltimore, Lima, Nashville, Chicago, Portland, Oregon and Los Angeles.

14. Will Shell sell mixed loads of Shell Isoprene Rubber and SBR at carload prices? Yes. Mixed loads of Shell Isoprene Rubber and any of the SBR types on Shell's price list will be shipped from Torrance at applicable carload prices.

Shell Chemical also stocks many of the more popular SBR polymers at Eastern warehouses. These may be purchased to round out loads meeting minimum tariff weights required for truckload or carload prices.

15. Will Shell Isoprene Rubber completely replace natural rubber? Only in the event of a national emergency.

A U. S. Cabinet Member recently stated: "Commercial development of polyisoprene is an important aid to national defense. Its availability in sufficient quantities will free the United States completely from dependence on foreign sources of rubber in time of emergency."

16. Are samples and technical information available? Yes. Simply write or call your nearest Shell Chemical, Synthetic Rubber Division sales office.

They are: 110 West 51st Street, New York 20, N. Y., JU 6-5060; 1296 Union Commerce Building, Cleveland 14, Ohio, TO 1-8096 and 5230 Clark Street, Lakewood, California, SP 3-4997.

Samples of new Shell Isoprene Rubber and technical information are yours for the asking.

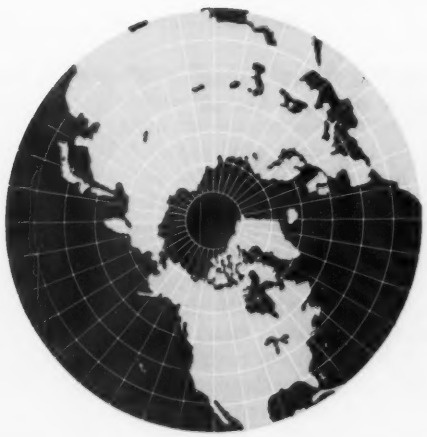
A Bulletin from

Shell Chemical Company

Synthetic Rubber Division

Sales Offices in: Chicago • Boston • Akron • Atlanta • Houston • Los Angeles • San Francisco • Toronto

CARBON BLACK WHEN YOU WANT IT



Whatever the clock may say... wherever you may be... a Witco-Continental Sales Office is ready to take care of your carbon black needs. Witco-Continental's plants are operated on a **continuous** production basis to assure you of quality carbon black in all grades whenever you need it.

The moment you contact a Witco-Continental representative, a "Unified Control" system goes to work for you. Your requests are channeled through one integrated world organization to give you the product or service you need... backed up by advanced research and production facilities... in the shortest possible time.

Witco-Continental has expanded its capacity by fifty per cent—further assurance of getting the carbon black you want when you want it.

WITCO CHEMICAL COMPANY, Inc.
122 East 42nd Street • New York 17, N. Y.
CONTINENTAL CARBON COMPANY
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Solvent Shipment Late Again?

Time To Switch To Skellysolve!

Late solvent shipments can be costly as well as annoying. But there's an easy way to put an end to the problem. Just switch to Skellysolve. When you do, you can count on getting the kind of dependable delivery you want. Here's why:

First, there's no time lost waiting for your order to go "through channels." Your order is phoned direct to the plant. Chances are your shipment will be on its way the next day. (Nine out of ten orders for Skellysolve are!) And here's another important advantage . . .

Contaminated solvent is no problem when you order Skellysolve. That's because Skellysolve is carefully checked during production *and* before shipment. And all tank cars are inspected before loading.

The next step is up to you! It's an easy one. Call LOgan 1-3575, Kansas City, Missouri. Ask for Les Weber. We'll bet a grandfather's clock against a dollar watch you'll never have solvent problems again.

Skellysolve for Rubber and Related Industries

SKELLYSOLVE-B. For making quick-setting cements for the shoe, tape, container, tire and other industries. Quick-drying, with no foreign taste or odor, in dried compound. Closed cup flash point about −25° F.

SKELLYSOLVE-C. For making quick-setting cements with a somewhat slower drying rate than those compounded with Skellysolve-B. Closed cup flash point about 13° F.

SKELLYSOLVE-H. For general use in manufacturing operations and cements, where faster evaporation rate than that of Skellysolve-C is desired. Closed cup flash point about −16° F.

SKELLYSOLVE-L. For general manufacturing operations where a medium evaporation rate is required. Closed cup flash point about 12° F.

SKELLYSOLVE-R. For general use in tire building and a variety of other manufacturing operations and cements. Reduces evaporation losses. Medium quick final dry. Lessens bloating and skinning tendency. Closed cup flash point about −25° F.

Ask about our
Skelly Petroleum Insoluble **Grease**

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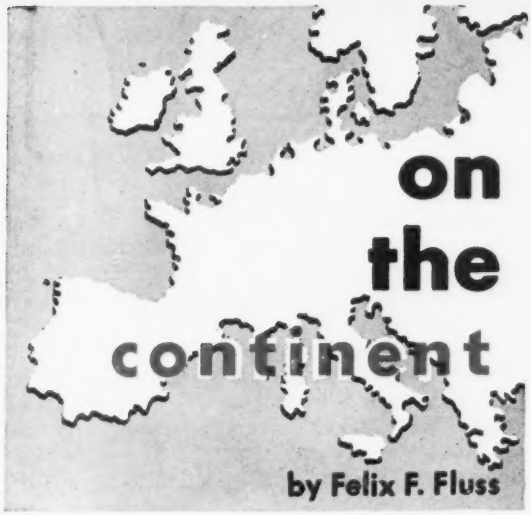

• **Heat and Butyl Rubber Processing.** The influence of heat treatment on butyl rubber processing has been investigated by C. Gangloff who reports in a French publication that when butyl rubber, compounded with reinforcing carbon blacks, is submitted to heat treatments aimed at improving certain properties in vulcanizates, processing characteristics are influenced too. The action of two promoters—paradinitrosobenzene and N-methyl-N-nitroso-paranitrosoaniline—on compounds reinforced with MPC, FEF and FT blacks, is studied for varying treatment conditions (temperature and time). Processing characteristics were noted through viscosity and scorch time measurements.

This study shows that special characteristics result from the use of paranitrosobenzene. Both promoters, when adequately used, will improve processing properties and give cures with considerably improved modulus rates.

• **Semi-Paste Rubber in Tubes as an Export Item.** The hardware trade is booming in many countries, judging from the numerous requests which our Commercial Attachés have received from many nations all over the world. The Bureau of Foreign Commerce of the U.S. Department of Commerce has recently published an elaborate list entitled "Possibilities for Expanded or New U.S. Export Markets." Such countries as Argentina, Australia, Burma, Italy, Korea, Mexico, Kuwait, New Zealand, Norway, Saudi Arabia, Switzerland, Trinidad and Uganda, have expressed great interest in hardware items.

Rubber in semi-paste form in tubes is already a standard item in American hardware stores, and right now there are opportunities to export it to many countries. This material simplifies many repair and maintenance jobs. Originally it was developed for use in industrial plants, but it is now available in handy four-ounce tubes which sell for less than $1.

The New York Times, on December 25th, published an article on the applications of these adhesives. It is pointed out that because they stick to almost anything (as long as the surface is clean and dry) these semi-paste rubber compounds can be used for such widely diverse jobs as: sealing leaks in pipes, caulking cracks or seams around roofs and vent pipes, repairing splits or cracks in garden hose, stopping leaks in boats, caulking around auto windshields and caulking of exterior windows and doors. They can also be used for sealing joints and around bathtubs and sinks, as well as for the resetting of loose wall tiles and the filling of fine cracks in masonry or brick work.

When a gasket is needed to assure an airtight or watertight joint on pumps and similar equipment, these rubber compounds enable the home handyman to easily form his own by simply squeezing concentric circles of the compound onto parts. The material can also be used for sealing leaky joints on home appliances, such as washing machines, water pumps, and dishwashers. Layers can be built up to replace worn sections on rubber door gaskets or worn belts.

Since the dried compound has electrical insulating characteristics, a coating can be used to patch worn spots on electric wires or cables, to waterproof automobile and power mower ignition systems, and to provide an insulating cover on exposed terminals of electrical plugs and similar connective devices. This mending material is ideal for repairing of rips or tears in canvas tarpaulins, tents and outdoor furniture, because the rubber dries to a permanently flexible film, and because it will bond to almost any material (leather, plastic, fabric, rubber, metal, wood, etc.).

An attractively designed tube which bears suggestions for applications along the lines mentioned above, would certainly be an excellent item in every hardware store in many parts of the world. Directions would also have to be printed in the native language and the use of a few illustrations would certainly stimulate sales.

• **Why Are Our Exports Lagging?** When recently addressing the Boston Conference on Distribution, the Assistant Secretary of Commerce for International Affairs, Bradley Fisk, pointed out that out of 280,000 manufacturing concerns, only a mere 12,000 are directly participating in exports, although very great opportunities in foreign markets are currently available to United States business.

Besides utilizing the opportunities which present themselves all over the world, we also have to improve the quality of our business performance abroad. The many reports which have been received read like a catalogue of deficiencies. The complaints range all the way from indifference to, and neglect of, export business at the highest policy level in many U.S. companies, to mishandling or ignoring details of foreign correspondence and export shipping. Some of the leading points are:

(1) Lack of sales promotion effort, especially by U.S. representatives; that is, an outright absence of

the direct selling efforts which are normal in domestic business.

(2) Backwardness and inefficiency of foreign distributive arrangements; failure to quote delivered prices.

(3) Failure to arrange realistic terms of credit; failure to adapt U.S. products in design and price to foreign markets.

(4) Deficiency of market research to discover both the nature and extent of foreign market opportunities.

(5) Inadequacy of technical information on complicated equipment; deficiency of servicing arrangements.

In contrast with all or many of these criticisms, there are numerous examples of good U.S. business performances in export business. An increasing number of companies are aggressively seeking export sales and are doing so intelligently with good basic market research, distribution and sales promotion, product design and pricing, credit and service facilities. If other business performance could be brought up near that of the best, much of our export problem would be solved. We must remember that industry is a customer-satisfying process, not just a goods-producing process.

• **Show Your Products at the U.S. Overseas Trade Exhibitions.** The office of International Trade Fairs of the U.S. Department of Commerce has just published the list of official U.S. Trade Exhibitions overseas. Twelve exhibitions are so far listed, to be held in 1961. Participation in these trade fairs is an excellent, inexpensive way to establish contact with a number of countries and to open up new markets. Trade Fairs will be staged in Colombo, Ceylon (January 21 to February 19); in Cairo, Egypt (March 21 to April 21); in Tokyo, Japan (April 17 to May 7); Turin, Italy (May 1 to October 31); Helsinki, Finland (May 26 to June 11); South America, location to be announced later (May or June); Poznan, Poland (June 11 to 25); Zagreb, Yugoslavia (September 9 to 24); Berlin, Germany (September 16 to October 1); Lima, Peru (October 12 to 29); Tunis, Tunisia (October 13 to 29); Accra, Ghana (November); New Delhi, India (November 14, 1961 to January 1, 1962).

Additional information can be obtained either from the U.S. Department of Commerce, Washington 25, D.C., or from any one of the 33 field offices in every major city of the United States. The New York City field office of the U.S. Department of Commerce is located in the Empire State Building.

• **German V-Belt Cartel.** The seven German V-Belt factories have filed an application with the Federal Office of the Administration of Cartels, stipulating uniform discounts. If the annual sales amount to DM 10,000 ($2,500) a discount of two per cent will be granted, which increases gradually up to twelve per cent provided that the minimum sales amount to DM 300,000 ($75,000).

The members of the cartel have stipulated that these discounts will only be granted to sales which have been booked by their member companies. But the Federal Cartel Office is of the opinion that nowadays all sales—even from outsiders—should be liable to the uniform discounts.

In view of the formation of the European Common Market, whereby six nations are trading with each other, the Federal Cartel Office is of the opinion that not only sales of German suppliers, but also sales from the other five nations are subject to the uniform discounts. These trade discounts will be granted by the factories to the wholesalers or probably to large retailers; the question arises whether the discount of two to twelve per cent will be sufficient to cover the cost of doing business.

• **Phoenix Gummiwerke A.-G.** This leading rubber company in West Germany was able to increase its production during 1960. However, increasing competition of foreign suppliers of tires and rubber shoes made it a little harder to maintain the position on the German market; in view of the slowing down of the German boom, the competition among the German factories has also become keener. In order to keep step with the flow of orders, approximately 100 foreign workmen had to be hired. Up to now prices have been stable and have not been increased, although some of the raw materials went up in price. Usually 7.4 per cent of the staff is sick which is a very precarious situation because the insurance system can only operate in the black if not more than 6 per cent of the crew are laid off.

There is no reason to be worried by the various rumors about the automobile industry. Of course, if production of compact or small cars drops, the supplying industries, among them the tire factories, will be affected. However, in view of the continued market observation such a contingency will not occur because management will take steps in time to switch production to other items.

• **The Rubber Research Institute of Malaya.** This organization, established in 1925, was founded to conduct research on rubber production. Funds are provided by a voluntary tax on exports of rubber from Malaya. Contributions are also received from other producing territories. The Institute is administered by a board consisting of Government nominees and representatives from planting organizations.

Dr. W. J. Wald, a Neville Senior Scientist, places a rubber sample in a plastometer in Neville's new rubber laboratories.

Constant research is conducted in the use and application of coumarone-indene resins in rubber compounding.

Your plastometer will show you why Neville C-I® Resins are a superior aid in rubber processing

The unique degree of plasticity derived from the use of Neville Coumarone-Indene Resins in rubber brings many benefits to your processing. You'll obtain improved mold flow, better knitting and a thinner flash line. Mixing, milling, calendering, and tubing will be faster, smoother, and cures will be more uniform.

But processing aid is not the only advantage gained by using Neville C-I Resins. You'll find marked improvement of tensile strength and elongation in many high quality formulations. Moreover, these resins are economically priced and may be used effectively to lower pound volume cost in highly loaded stocks while retaining physicals. They are available in flaked and solid form and in a wide range of colors from ½ to 16 Neville. Softening points are from 10° C. to 155° C. Use the coupon below to write for further information.

Resins—Coumarone-Indene, Heat Reactive, Phenol Modified Coumarone-Indene, Petroleum, Styrenated, Alkylated Phenol • **Oils**—Shingle Stain, Neutral, Plasticizing, Rubber Reclaiming • **Solvents**—2-50-W Hi-Flash*, Wire Enamel Thinners, Nevsolv* • **High Purity Indene.** Trademark

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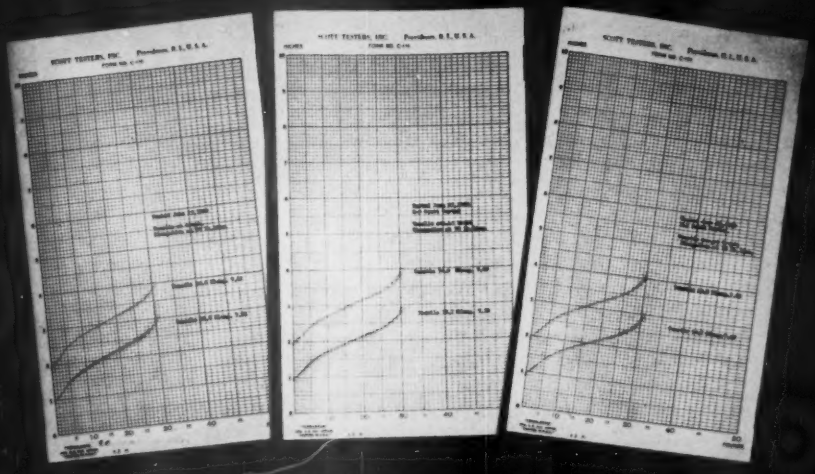
REPORT CARDS FOR THE WORLD'S MOST MODERN TIRE CORD PROCESSING INSTALLATION



Top grades are being assigned to the tire cord produced on the Armstrong Tire & Rubber Company's triple-zone rayon/nylon processing line which went into production a year ago at Des Moines.

Tensile strength of the tire cord consistently hovers within a few tenths of a pound around the 31 psi mark, and elongations achieved are exactly those specified for maximum tire life.

These results are attained day in and day out, without the need for time-consuming experimentation and adjustment. They are likewise consistent across the whole face of the fabric, with maximum tensile variation of a fraction of 1% at any point in the web width.

This Litzler designed and constructed line has the best of "attendance" records, too. From the time of startup, two weeks after installation completion, the line has been running at rated capacity with negligible maintenance.

For consistent, top results in tire cord processing; for the most productive designs in the world . . . for the most reliable engineering in this specialized field . . . consult the engineers of the

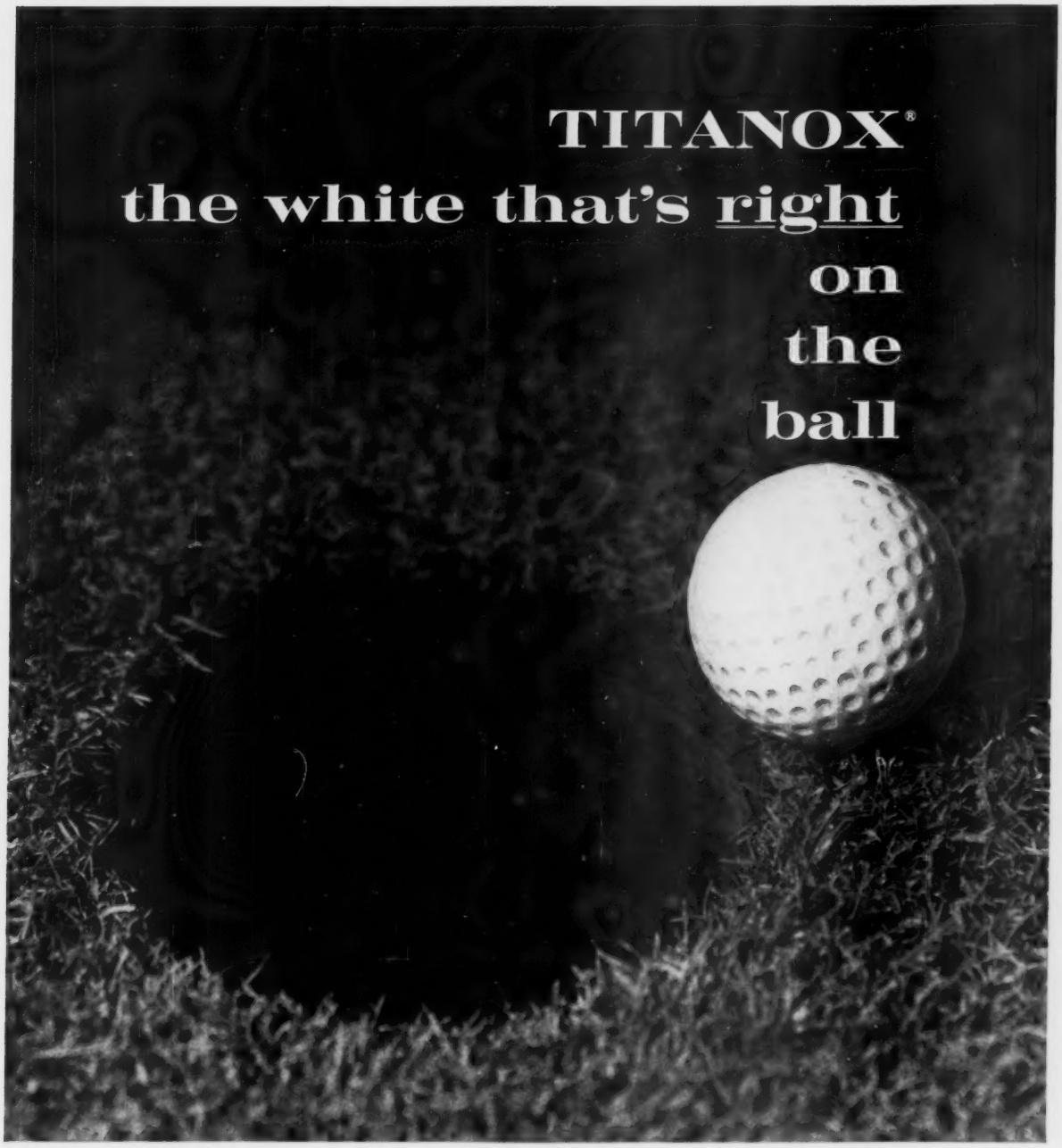
C. A. LITZLER CO., INC.

SOUND ENGINEERING FOR TOMORROW'S PRODUCTION

235 BROOKPARK RD. CLEVELAND 9, OHIO CABLE "CALITZ"

EXPORT REPRESENTATIVE: GILLESPIE & CO. OF N. Y., 96 WALL ST., NEW YORK 5, N. Y.

LICENSED FABRICATORS: Benno Schilde Maschinenbau A. G., Bad Hersfeld, Germany; Soc. Alsacienne de Constructions Mecaniques, Paris, France; Mather & Platt, Ltd., Manchester, England



To give their products outstanding visibility on the fairway and at the sales counter, golf-ball manufacturers rely, among other things, on an unbeatable threesome that includes the right compounding ingredients, the right vulcanizing conditions and the right TITANOX pigments.

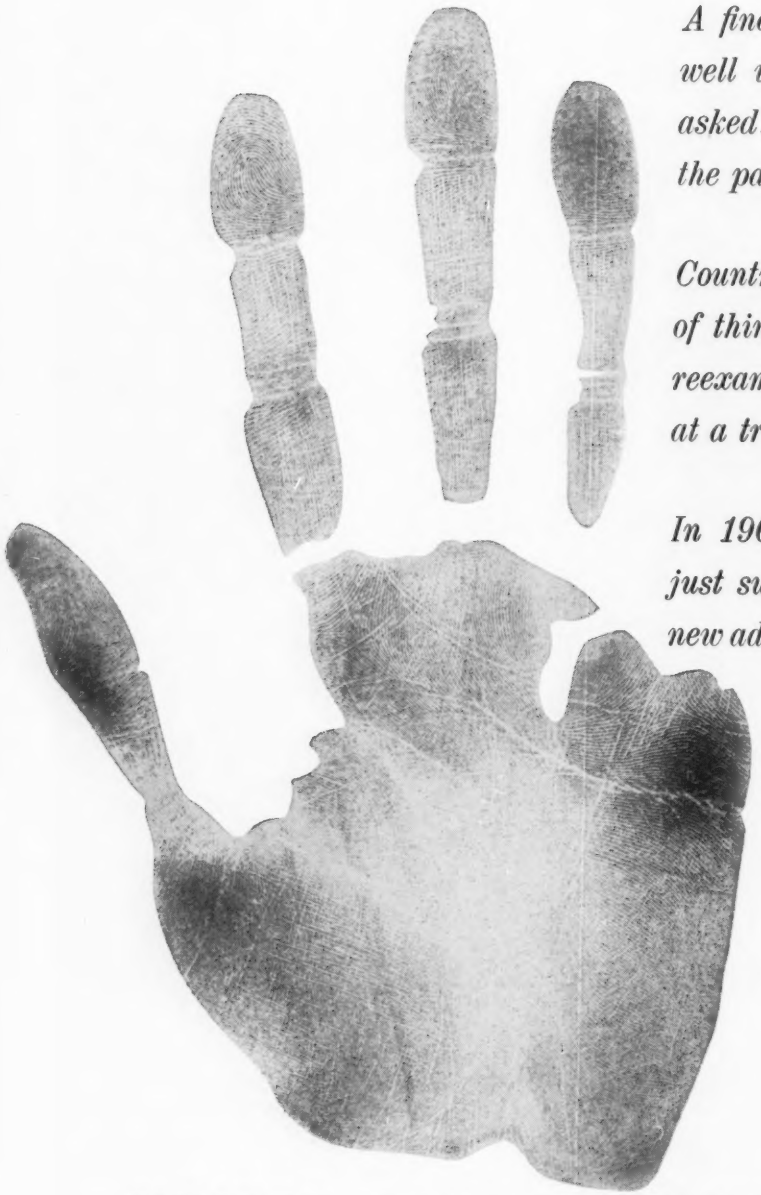
These white titanium dioxide pigments are ideal for whitening and brightening golf balls—from the raw material used for cover stock to the final bright coating applied to the finished ball.

As it is with golf balls, so it is with a wide range of other rubber and plastic products—there's a TITANOX white pigment to do the job efficiently. Titanium Pigment Corporation, 111 Broadway, New York 6, N. Y. In Canada: Canadian Titanium Pigments Ltd., Montreal.

TITANIUM PIGMENT CORPORATION
SUBSIDIARY OF NATIONAL LEAD COMPANY

8003

"KNOW THE COUNTRY LIKE THE PALM OF MY HAND"



A fine statement and it stood up very well until a quiet rubber compounder asked: "How well do you really know the palm of your hand?"

Countryside common sense is the type of thinking that demands a pause and reexamination of the details to arrive at a true perspective.

In 1961, United Carbon will provide just such a perspective. Watch for our new advertisements to begin next month.

UNITED CARBON COMPANY, INC.
410 PARK AVENUE, NEW YORK 22, N. Y.
A Subsidiary of United Carbon Company

AKRON CHICAGO LOS ANGELES
BOSTON HOUSTON MEMPHIS

In Canada: CANADIAN INDUSTRIES LIMITED

UNITED CARBON

ROYLE STRAINERS MEAN RUBBER PROFITS

Royle 4A Strainer

As an example—Royle Strainers, with new, quick-opening heads, assure much longer production runs than ever before possible and considerably less down-time.

The large screen area gives more production time between screen changes; while the new breech-lock head, with automatic hydraulic-pneumatic operation allows for quick screen changes.

There are many other practical advantages built right in to Royle Extruders, for instance:

Heavy Duty Gear Case—with self-lubricating, opposed helical gears that were Royle designed and engineered specifically for strainer operations.

Powered Cut-Off Knife—with either rotary or up-and-down motion and adjustable cycling to give variable length products.

Longer L/D Ratios—allow mixing operations to be performed in the extruder. This gives a continuous and, hence, more economical mixing method than other operations.

Write today for complete Royle Strainer information. There is no obligation on your part.

ROYLE
Paterson, N. J.

John Royle & Sons, 4 Essex Street, Paterson 3, N. J.

Please, send me full information about Royle Strainers.

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____

JOHN ROYLE & SONS

Pioneered the Continuous Extrusion Process in 1880

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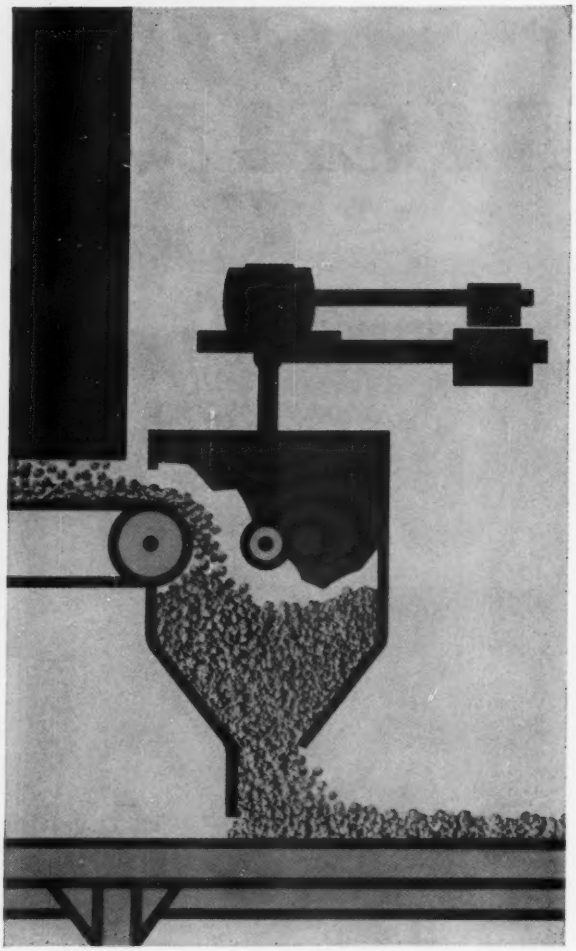

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An editorial appraisal of the rubber industry and comments by industry leaders written expressly for the readers of RUBBER AGE

1960 REVIEW & PREVIEW 1961

THE GENERAL ECONOMY

We enter the new year plagued by many difficulties—political and economic. Domestic productive growth continues but in an atmosphere which can best be described as "profitless prosperity."

We expect for 1961:

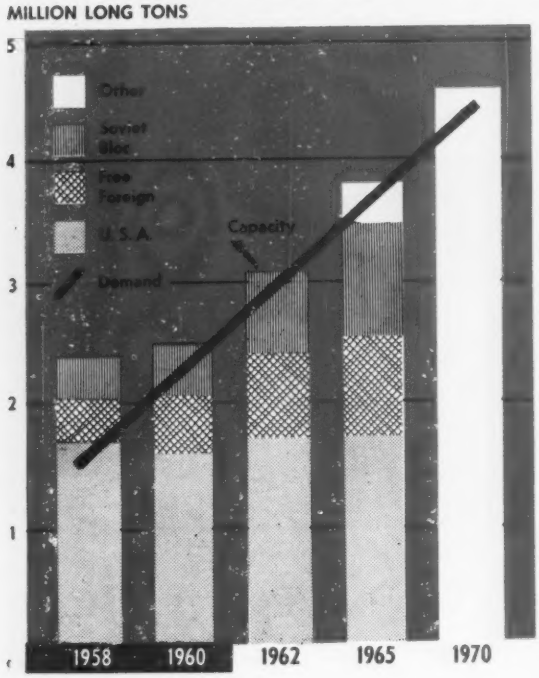
- A gross national product of $510 billion.
- An increase in Federal spending.
- High employment and unemployment.
- Higher personal incomes.
- Reasonably higher consumer spending.
- A slight downturn in capital spending.
- Industrial production to edge upward.

Gross National Product—It is generally agreed by most economists that the gross national product will rise in 1961, probably to about $510 billion, or about $10 billion more than in 1960. This, in itself, is not too remarkable a fact when we consider that even in the "recession" years of 1957 and 1958 the GNP showed successive increases.

What enters into this consideration, however, are the estimates that employment and personal income will reach new highs in 1961. There are also indications that consumer spending will rise moderately. The Federal Government has already taken several actions to help redress the deficit in the balance of payments of the United States and there is every reason to believe that it will continue to make every effort to narrow the gap where this deficit is concerned by promoting and encouraging exports. This, despite the fact that exports of merchandise in the third quarter of 1960 exceeded imports by an annual rate of some $5 billion, nearly $1 billion higher than in the preceding quarters.

WORLD SYNTHETIC CAPACITY AND DEMAND

MILLION LONG TONS



Federal Spending—It seems reasonable to expect that if the current unemployment trend continues the government will take measures through public works or some other means to alleviate the situation. We can also reasonably expect greater outlays for national defense. We also must not overlook the continuing increase in expenditures by local and state governments. Many knowledgeable persons believe that by the end of the 1960's the state and local governments will be spending more annually than the Federal Government.

Employment—A paradoxical situation exists here. It is generally believed that employment will be at high levels throughout most of 1961. True, there may be some fluctuation, but the general outlook is good. On the other hand, rising population and increasing automation mean increasing unemployment. At the moment, unemployment is hovering at a 5 million level. We are of the opinion that unemployment during 1961 will average some 6 per cent of the total labor force.

Personal Income—In consideration of relatively high employment expected in 1961 and somewhat higher wage rates, we expect that personal income in 1961 will top the estimated $404 billion in 1960 by close to $5 billion. It must also be recognized that taxes will keep pace with income. The consumer is not likely to get any tax relief, either federal or local, in 1961. Disposable income, placed at $354 billion in 1960, may increase to close to $360 billion in 1961.

Consumer Spending—In general, consumer spending in 1961 is expected to rise moderately, keeping pace with income. What must be recognized is the fact that personal debt is becoming a more potent factor with each passing year in that it puts a limitation on that which an individual consumer may spend in a given period. Consumer debt will continue to rise in 1961. As a result, consumer spending on durable goods will likely suffer.

Capital Spending—Although plant and equipment expenditures for the year 1960 will total approximately $36 billion, 10 per cent above 1959, a downturn in such expenditures is expected in 1961. Capital spending by manufacturers will probably drop from the $15 billion in 1960 to approximately $13 billion in 1961. Although the over-all total will drop, industry expects to boost its spending for new facilities overseas by about 6 per cent.

Since the profit squeeze which has been evident for the past two years will continue into 1961, major emphasis will be placed on cost control at the operating level. This means that management must make new efforts to operate present facilities more efficiently rather than invest in new plants. All cost elements will have to be constantly examined and labor costs will prove no exception.

American capital investments in foreign countries have sustained a large-scale growth in recent years. The total value of direct investments abroad now aggregates over $30 billion. A probable total of $2 billion was invested in 1960. Capital spending by U.S. companies in foreign countries accounted for almost 9 per cent of total plant and equipment outlays in the 1957-59 period. Over 40 per cent of the total foreign outlays in 1960 were in Europe, with expenditures rising sharply in Common Market countries.

The United States invested approximately $400 million in Canada during 1960, about the same as in 1959. In Latin America, plant and equipment outlays of $234 million by U.S. manufacturers in 1960 continued the upward trend set in 1957. In other areas of the world, expansion of facilities by U.S. companies has been concentrated primarily in the industrialized countries of Australia, Japan and the Union of South Africa. There have been modest expenditures in India and the Philippine Republic.

The general economic situation and the current political facts of life may tend to curb continued expansion of overseas investment. However, economic pressures in this country are strong. In balance, we may expect a continuation of overseas capital investments, but at a slightly slower rate.

Industrial Production—The Federal Reserve Board Index of Industrial Production has been set at 110 for 1960 (1957 = 100), and we expect a moderate increase to perhaps 112 in 1962. The deteriorating international situation may force the Federal Government to bolster the economy through one method or another. In addition, we come back to this matter of "profitless prosperity" in that rising production will take place despite expected drop in profits.

Conclusion—In essence, we foresee that 1961 will be only "slightly better" than 1960 in most categories. American business is now operating in an atmosphere in which many decisions have been taken out of its hands. The international situation, for one, is forcing the Federal Government to exercise greater and greater control over all spheres of human activity and the business world is no exception. Under these circumstances it may almost be said that the sphere of independent action for business has been severely circumscribed.

We have often heard it said that in the field of international politics the government has been "reacting" rather than "acting". Business has now been placed in this position. More often than not, these days, the motivating influences are governmental actions rather than economic conditions. Business will have a narrow path to tread in 1961, but the indications at this point are that it will successfully (if not triumphantly) travel its route. The question which must now be asked is: Is "slightly better" good enough?

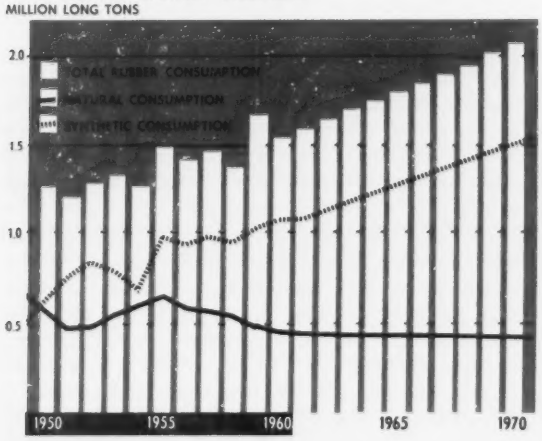
THE RUBBER INDUSTRY

"Just a little better" than 1960 is the way that most rubber company economists see the new year. New rubber consumption will be up, tire shipments will be up, and synthetic rubber production and consumption are expected to set new records.

▶ The rubber industry in 1960 experienced disappointments in both over-all consumption of new rubber and in profit on sales. Consumption of approximately 1,555,000 long tons of new rubber was some 75,000 long tons below the previous year, while the per cent of profit on sales dropped slightly from 4.0 per cent in 1959 to approximately 3.9 per cent in 1960. Of the 1960 consumption, synthetic rubber accounted for 69 per cent.

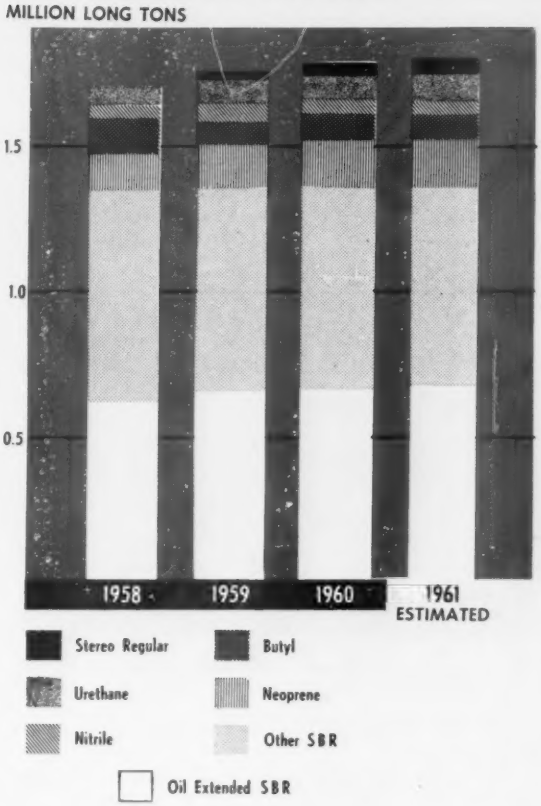
U. S. LONG RANGE TRENDS

MILLION LONG TONS



U. S. SYNTHETIC CAPACITY

MILLION LONG TONS



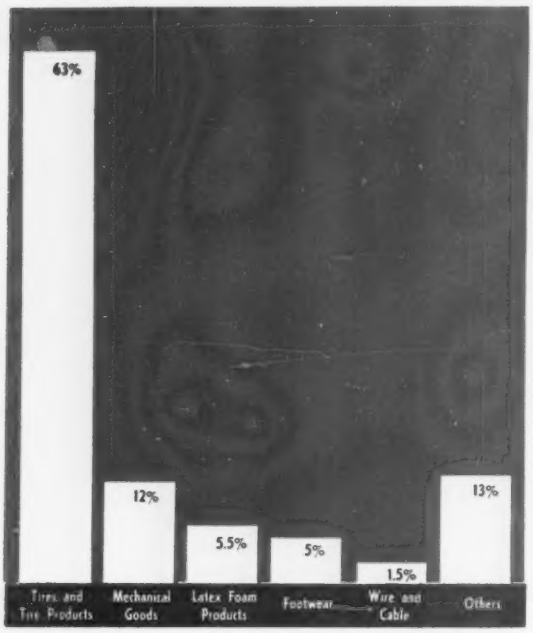
Total consumption of new rubber in 1961 will probably reach 1,600,000 long tons, with synthetic rubber accounting for 1,150,000 long tons and natural rubber for 450,000 long tons. If these figures prove accurate, synthetic rubber will capture approximately 71 per cent of the new rubber market in the United States in 1961.

As for world rubber consumption, this is expected to be at or near 3,800,000 long tons in 1961, exclusive of Soviet Bloc figures. Of this total, some 37 per cent will be synthetic rubber. It is generally agreed that the high cost of natural rubber throughout 1960 has forced a new turn to synthetic, not only in the United States, but throughout the world.

Particular emphasis is being placed on the newer natural-synthetics. Brought into commercial production during 1960, the capacity for producing these "stereo"' rubbers in the United States alone is expected to grow to 375,000 long tons annually by 1965. Productive capacity abroad, outside the Soviet Union, should reach 180,000 long tons by that time.

Many industry figures are agreed that the market that these tonnages represent would have gone to natural rubber if the newer synthetics had not made an appearance. The United States in recent years has been consuming about 25 per cent of the total world supply of natural rubber. As a result, varying requirements in this country have played a

U.S. NEW RUBBER CONSUMPTION 1960



major role in the world supply-demand and market price structure.

The question most often asked revolves around the probable price of natural under these new conditions. Will the advent of the natural-synthetics force the price of natural down? Many economists have concluded that while the new synthetics will prevent rapid rises in the price of natural, they will not depress world prices. This is primarily due to the fact that world supply of natural is still short of world demand, and likely will continue to be in short supply for the next few years at least.

The potential producers of the stereo rubbers are aiming their sights at the biggest natural rubber market—tires. It is estimated that close to 400,000 long tons of natural rubber went into this segment in 1960. Styrene-butadiene rubber, even at a lower price, has not been able to pose a serious challenge to natural because of performance requirements. On the other hand, truck tires made with 50 per cent polybutadiene and 50 per cent natural rubber have proved superior to natural rubber tires as far as dissipating heat is concerned. Polyisoprene has proven equal, and in some cases superior, to natural rubber.

We may reasonably conclude, then, that the new natural-synthetic rubbers will present more of a problem to natural than to the older types of synthetic. True, there is now an over-capacity for styrene rubber, but this is not reckoned to be too serious a problem.

The natural rubber producers turned out 2,006,000 long tons during 1960, and it is expected that this figure will show a small increase during 1961. By 1970, it is estimated that 2,810,000 long tons of natural rubber will be produced. In truth, this will be a different natural rubber—it will be high-yielding, low-production cost rubber, if the best expectations of the producers come to fruition.

The matter of price, always of major significance, is likely to take on an even increased importance in the coming year. During 1960 the price of natural rubber swung in an even wider orbit than has been evident in the past several years, reaching a post-Korean war high of 47¢ per pound. In recent weeks it has swung sharply in the other direction and is currently around the 30¢ level.

That the producers of polyisoprene rubber intend to keep this material competitive with the natural product is indicated by its own price history. Originally introduced in late 1959 at 30¢ per pound, it was raised to 35¢ per pound, subsequently reduced to 32¢ per pound, and is currently selling at 27¢ per pound. As facilities for the production of the synthetic-naturals come into being, the impact upon natural rubber will be most definite. Earlier we ventured the opinion that for the short term the synthetic-naturals will not too greatly affect the price of the natural product.

What will affect the price of natural is the fact that the commodity has reached an "all or nothing" state. Within the next decade natural will either compete successfully with its synthetic counterparts, or it will cease to be a serious factor in the United States and, before too long, in the world.

In 1960, about 350,000 long tons of synthetic rubber were exported from the United States, and this was considerably higher than expected by many at this time last year. Foreign capacity to produce synthetic rubber has been on the increase during 1960, and it is reasonable to expect, barring unforeseen circumstances, that this figure will fall in 1961. A reasonable forecast would call for the export of 300,000 long tons of synthetic rubber from the United States in 1961.

Imports of finished rubber products are becoming of increasing concern to rubber goods manufacturers in the United States. Rubber footwear imports into the United States will set a new all-time record in 1960. The tide of foreign goods has prevented domestic producers from expanding their position in the expanding home market.

Rubber sundries manufacturers also have been showing concern over the importation of competitive goods. The Rubber Manufacturers Association reports that in rubber gloves alone, 1960 imports are likely to be double that for 1959. Domestic rubber goods manufacturers are thus caught in a squeeze in that they are unable to recover increased costs resulting largely from increased wage costs and fringe benefits.

In 1960, the rubber industry spent approximately $200 million for plants and equipment, of which some $55 million was invested in overseas facilities. Although, as previously indicated, a reduction of capital expenditures for all industry is anticipated for 1961, there are firm estimates that the chemical process industries will run counter to this trend, expending some $1.64 billion in 1961, an

increase of more than $30 million over 1960. Based on information gleaned from some of the most important companies in the rubber field, it is believed that the rubber industry itself will also run counter to the all-industry trend and will increase its expenditures for plants and equipment over the 1960 figure of $200 million with some $66 million going into foreign investment. (Note: Latest Department of Commerce figures place rubber industry capital expenditures in 1960 at $240 million, a 26 per cent increase over 1959).

Actions by the new administration may, of course, impede foreign investment or create an atmosphere in which it will be psychologically difficult for domestic companies to expand their overseas commitments. In balance, however, we do not see any decrease in the expenditures planned by domestic producers in overseas plant and equipment.

In total, we are of the opinion that the future for the rubber industry is one of continued growth. Rubber goods continue to be one of the most essential items in our domestic economy. The number of automobiles on the road increases each year. Our population is growing rapidly. Rubber technology continues to make rapid advances. Raw materials are in plentiful supply. There may be temporary dislocations—but the over-all picture is good.

TRANSPORTATION SEGMENT

General agreement is lacking, but most industry sources are of the opinion that by mid-1961 the economy will have recovered sufficiently to lend impetus to the tire market.

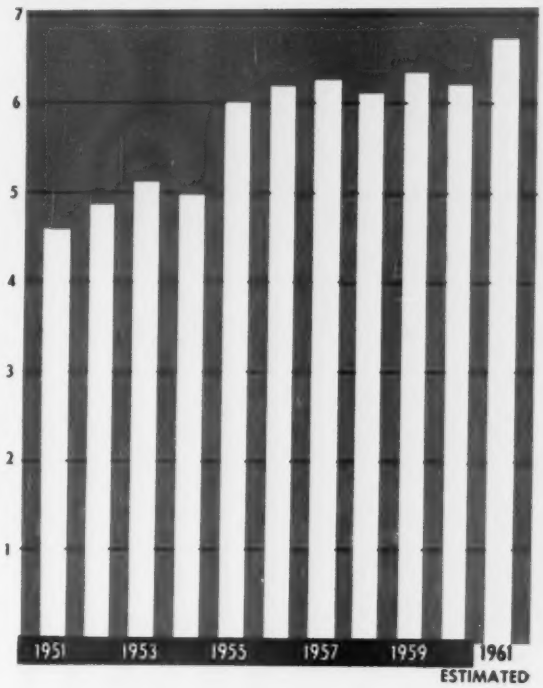
► In the last half of 1960, tire production was somewhat curtailed and there are some in the industry who predict that current conditions will extend through the first half of 1961. These sources say that original equipment tire production will reflect the approximate 10 per cent cutback in automobile production witnessed in the latter part of 1960. These same sources estimate that sales of original equipment tires in 1961 may even fall short of the 1960 level.

For all the unhappiness about the second half of 1960, the automotive industry enjoyed its second best year on record. Various estimates have been issued with regard to the output of domestic automobiles in 1961, but one outstanding authority has indicated that total sales may reach 6,700,000 units, of which 500,000 will represent imports. Even if 1961 meets, but does not exceed, the 1960 level in the automobile field, it will still be a pretty good year for original equipment tires. Approximately 36,000,000 original equipment tires were shipped in 1960, as compared with 29,782,000 in 1959.

The replacement tire market continues to exhibit very healthy tendencies, with almost 69,000,000 replacement passenger tire shipments made in 1960, as compared with 66,838,000 in 1959. There is general agreement that these shipments will exceed 71,-

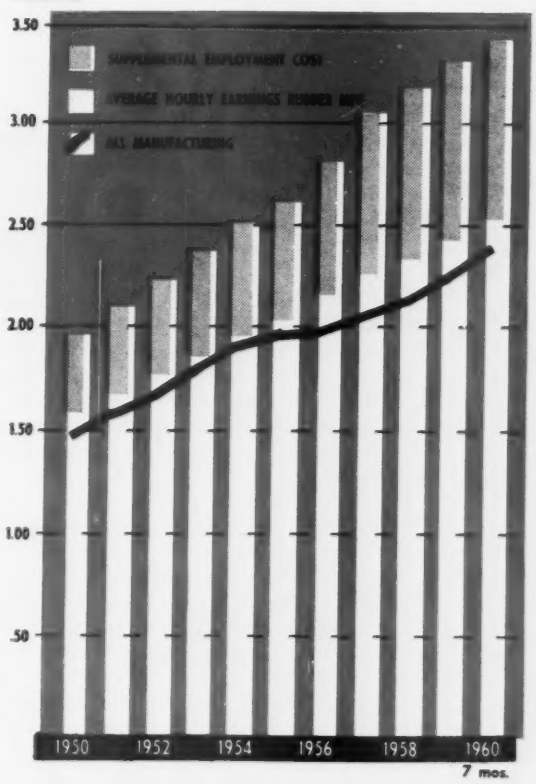
RUBBER MANUFACTURERS' SALES

MILLIONS OF DOLLARS

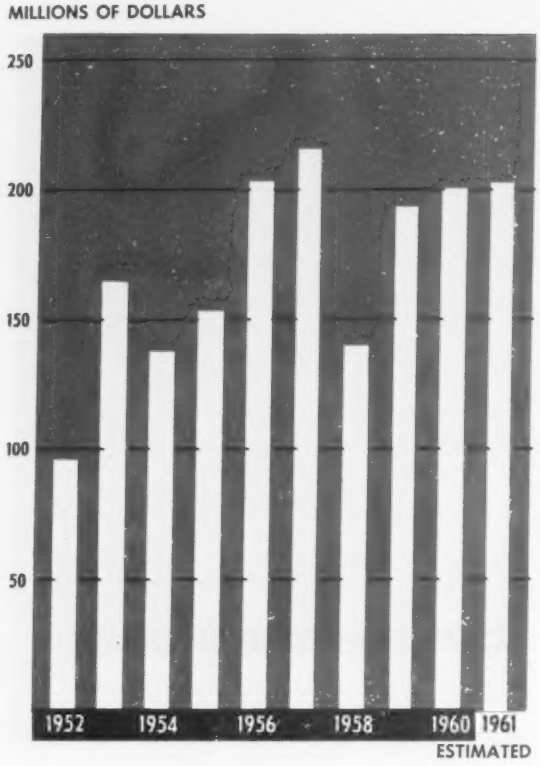


WAGE COST PER MAN HOUR PRODUCTION EMPLOYEES

DOLLARS



RUBBER INDUSTRY CAPITAL EXPENDITURES



000,000 units in 1961. Increases in shipments are also anticipated for both truck and agricultural tires in both the original equipment and replacement categories.

Although there are many economic reasons for the continued increase in the sale of replacement passenger car tires during 1961, the biggest factor actually is the steady growth in the number of cars on the road. According to the Department of Commerce, there will be almost 62,000,000 cars on the road by the end of 1960. Since the number of cars actually junked each year is less than the number of new cars produced, the actual number of cars on the road can be expected to increase annually for some time to come. This indicates that the annual increases recorded in replacement tire sales each year will continue for many a year to come.

Compact Car Factor

It should be noted that compact cars currently represent some 30 per cent of car production. Tire manufacturers point out that many of these cars will soon be coming into the market for replacement tires. It is also pointed out that the dollar return on each compact car tire sold is somewhat less than for a standard size tire.

The great number of new compact cars, both domestic and foreign, coming into the market each year pose a different set of problems for the tire manufacturer. For one, he is now forced to produce a greater variety of sizes than heretofore, and this complicates production and the maintenance of proper inventories by dealers.

One tire manufacturer has ventured the opinion that if tire prices today reflected the higher cost of labor and materials, they would be much higher. It is only the over-supply and the pressure on the market that is keeping tire prices as low as they are.

There may be some increases in tire prices during the year, particularly when increased sales begin to narrow down inventories. Small price-cost margins cut heavily into profits in the third and fourth quarters of 1960, and replacement tire earnings suffered. Here was a situation where passenger car replacement tire sales established a new record in 1960, but reduced profit margins were in evidence. Again we return to this matter of a "profitless prosperity."

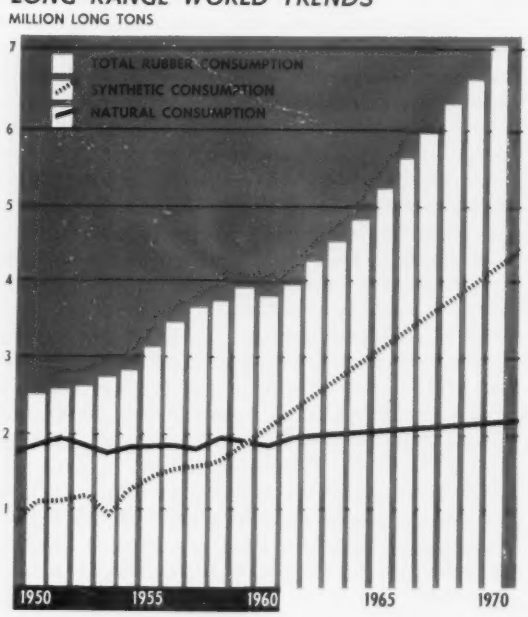
We conclude, however, that 1961 promises moderate improvements (over-all) in production, sales and earnings for the tire industry. We further believe that most of the expected improvements will come in the second half of the year.

NON-TRANSPORTATION SEGMENT

The non-transportation segment of the rubber industry sagged slightly in 1960, from a production standpoint, but will probably recover in 1961 and continue the upward trend of recent years.

► The Federal Reserve Board Index of Industrial Production for the first eight months of 1960, using 1957 as 100, was 109.0. During the same period, the index of rubber consumed in the production of non-tire goods was 104.9. This latter figure is the same

LONG RANGE WORLD TRENDS



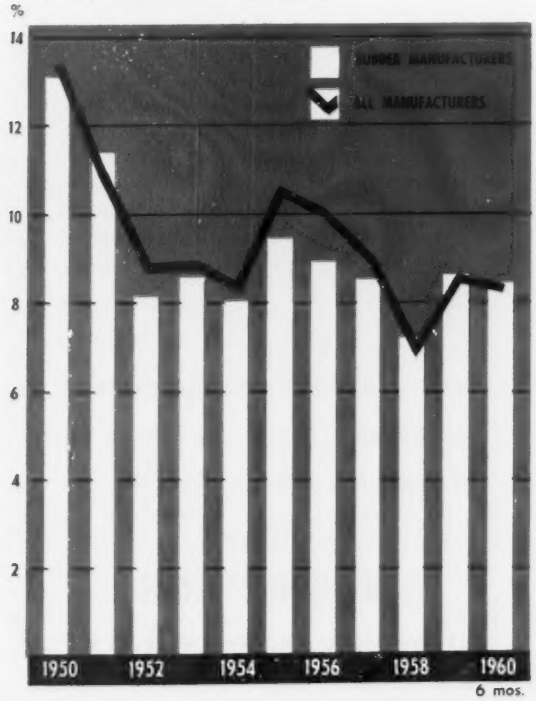
as the over-all FRB index for all of 1959, for which period the index of rubber consumption in non-tire items was 112.1. From this, it may be seen that although non-tire rubber consumption in 1959 (112.1) was ahead of the FRB over-all index of 104.9, this segment of the industry lost ground in 1960 when its index of 104.9 is compared with the FRB's 109.0. In the first eight months of 1960, the non-tire group consumption did not hold up as well as consumption in tire goods which, at 107.5 for the 1960 period, was only about 3 points below its performance in 1959.

Of the 1,555,000 long tons of new rubber consumed in 1960, we estimate that 63 per cent went to the transportation segment. Of the balance, we estimate that mechanical goods accounted for 12 per cent; latex foam products for 5.5 per cent; footwear for 5 per cent; wire and cable for 1.5 per cent, and miscellaneous for 13 per cent.

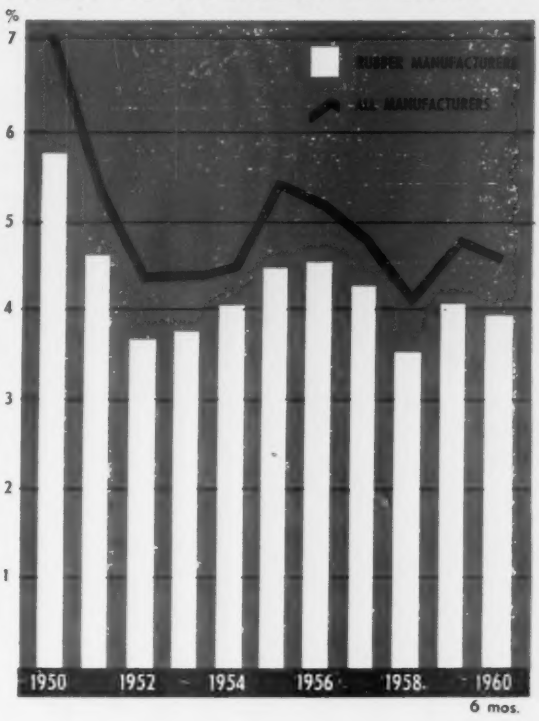
When we apply our percentages to the quantities of new rubber consumed in 1959 and 1960, we find that footwear, wire and cable and latex products seem to have suffered in 1960. As for footwear, no elaboration is needed here. The impact of foreign imports continues to be felt. At this point, 1961 does not seem to hold much hope for this part of the market. The only thing that could pull footwear out of the doldrums would be governmental action and extreme winter weather conditions. Even governmental action might be a temporary expedient.

The wire and cable segment continues to lose ground to plastics. It should be pointed out, however, that the plastics which are making significant inroads are rubberlike plastics, and while some types of elastomers have had serious declines, the balance is not too bad.

PERCENT RETURN ON INVESTED CAPITAL



PROFIT AS A PERCENT OF SALES

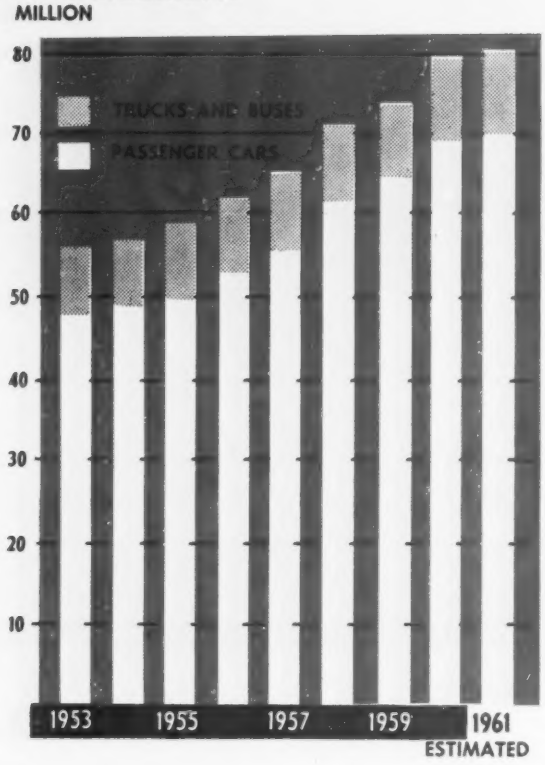


We come now to the matter of latex foam products. Certainly, it is no secret to the industry that latex foam products have not been doing as well in 1960 as they did in 1959. Two major reasons are advanced for this: (1) The high price for natural rubber latex which existed all during 1960, and (2) the inroads made by urethane and plastic foams.

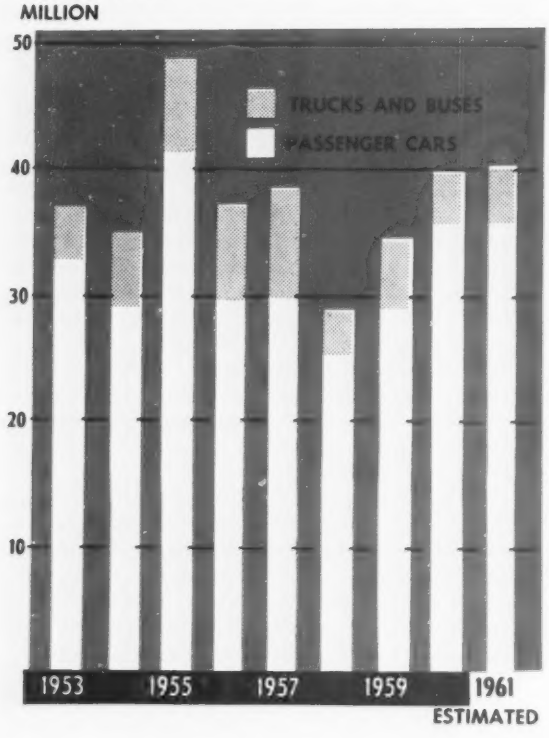
It is difficult to determine which of these points are the more important since, in a sense, they are somewhat inter-related. While the urethane and plastic foams have made definite technological advances in the past few years, they still have not captured the large part of the market represented by the bedding field, namely, mattresses and pillows. They have made considerable headway in furniture and automotive cushioning. Despite the price competition which was prevalent throughout 1960, latex foam products just about held their own from a consumption standpoint, but fared rather badly from the profit angle. The high cost of natural latex which prevailed for most of the year contributed substantially to the profit drop.

The vagaries of price contributed to the decision of at least one major foam rubber manufacturer to abandon production of this commodity to concentrate on urethane foam. We continue to feel that price is the problem. Let the price of latex come down, and latex foam rubber will do well. There is, it seems to us, room in the marketplace for both latex foam rubber and for urethane and plastic foams.

U. S. TIRE SHIPMENTS REPLACEMENT



U. S. TIRE SHIPMENTS ORIGINAL



This we present as a short-term proposition only. In future years, urethane and plastic foams may make those technological advances which will make them competitive with all types of latex foam rubber from the standpoint of both quality and price. Different factors will then be at work and we shall then have to draw different conclusions.

In balance, we see continued prosperity for the non-transportation segment. While the general production and sales of industrial rubber goods declined somewhat during the past year, we believe this to be a reflection of the general state of the economy. As 1961 picks up, so will industrial rubber goods. As a matter of fact, even during 1960, conveyor belting is reported to have bucked the trend and activity for this product increased over the previous year.

Rubber sundries present somewhat of a problem and imports are beginning to make themselves felt. In this category, however, we estimate that there will be no serious dislocation in production and sales during 1961.

While footwear is off, heels and soles have been doing relatively well and should continue to do so throughout 1961. Adhesives are doing very well and should make new strides in 1961.

What bothers the non-transportation segment of the rubber industry bothers the entire rubber industry. Higher wages and fringe benefits without commensurate increases in production efficiency, foreign imports, and the general lackluster economy.

Of all segments of the rubber industry, the non-transportation segment, by reason of its diversity of products, is least subject to monthly or even daily fluctuation. This segment of the industry holds perhaps the greatest promise in 1961.

Conclusion

We conclude that the rubber industry, as a whole, will experience a satisfactory year in 1961. There are certain tangible assets on our side. The fact that most rubber companies are well-managed, modern and receptive to current tides and change. The fact that the rubber industry has an excellent labor-management record. It is estimated that rubber industry sales in 1960 totaled some $6.2 billion. For 1961, we foresee an increase to $6.5 billion. The future is secure.

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Editor

RUBBER AGE

101 West 31st St., New York 1, N. Y.

Statements from the industry

Synthetic rubber is expected to continue to capture a bigger share of the total rubber market, reaching 71 per cent in the United States and more than 37 per cent in the rest of the Free World.

J. W. Keener

World rubber consumption, exclusive of Iron Curtain synthetic rubber, should reach a new high of 3,800,000 long tons in 1961, an increase of one per cent above this year's record. United States consumption will be around 1,555,000 long tons, about the same as in 1960. The rest of the world will use approximately 1,800,000 long tons, an increase of three per cent over 1960. Iron Curtain natural rubber imports account for the remainder of the 3,800,000 long ton world estimate.

Synthetic rubber is expected to continue to capture a bigger share of the total rubber market, reaching 71 per cent in the United States and more than 37 per cent in the rest of the Free World. Total business activity will continue near current levels through the first half of 1961, but is expected to swing upward in the second half. The gross national product is expected to reach an all-time high of $513 billion, $9 billion above 1960.

Domestic sales of passenger car tires for replacement purposes are again expected to set a record of 72 million units, compared with about 69 million units in 1960 and 66.7 million in 1959. The number of cars and trucks on the road continues to increase each year. Even though some of these are compact cars, which have smaller tires, the over-all gain in the number of vehicles will keep rubber consumption high.

To supply growing markets around the world, B. F. Goodrich has been building new plants and expanding existing facilities on five continents during 1960. These include new tire plants in Melbourne, Australia; Campinas, Brazil; Kitchener, Ontario; Teheran, Iran; expanded facilities at Miami, Oklahoma, and a large plant now under construction in Indiana.

B. F. Goodrich Chemical Company, a division, announced construction plans for plants to produce Geon vinyl resin near Bogota, Colombia; Melbourne, Australia; and Long Beach, California. This division also announced facilities for production of chemicals in Argentina and a substantial expansion of its synthetic rubber producing facilities at Arnhem, The Netherlands. Construction of our sixth U. S. tire manufacturing plant is proceeding on schedule at Ft. Wayne with completion scheduled for the third quarter of 1961. A substantial expansion, which will include facilities for production of white sidewall tires, is under way at our Miami, Oklahoma, plant. B. F. Goodrich Canada Ltd., recently announced plans for a major tire plant to be erected in Kitchener, Ontario.

Our international division, International B. F. Goodrich Company, dedicated two new tire plants on opposite sides of the globe on the same day, March 22. One is owned by B. F. Goodrich Australia, Pty. Ltd., a subsidiary in which B. F. Goodrich is in partnership with Ampol Petroleum, Ltd., a major Australian oil company. The other is owned by B. F. Goodrich do Brasil, a subsidiary. Construction is proceeding on a tire and tube plant for our subsidiary, B. F. Goodrich Iran, S.A., in Teheran, Iran. It will be the first plant of its kind in that country.

An expansion to increase production of rocket motors has been announced for our Rialto, California, plant; new major distribution centers are being established for the Salt Lake City and St. Louis areas, and a new retread plant is being built near St. Louis. Other major distribution centers and tire retread plants were built at San Francisco and Salt Lake City recently. Our B. F. Goodrich Chemical division recently began production of vinyl resins and compounds at its new plant in Long Beach, California.

J. W. Keener

President, B. F. Goodrich Co., Akron, Ohio

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We believe that the industry will do as well in 1961, if not somewhat better, in certain areas of its widely diversified activities.

Ross R. Ormsby

On the surface, 1960 might appear to be a year of contradiction for the rubber industry in the United States. Manufacturers scored a number of impressive new records in a period when over-all new rubber consumption showed a slight decline from the record levels of 1959. Tire industry profits on sales and investment declined in most instances during the first half, a trend that appeared likely to continue through December, despite shipments of an estimated 123,180,000 passenger, truck-bus and farm tires in 1960, a truly impressive new record. The profit squeeze was due in large measure, of course, to increased material costs and further increases in wages and in the cost of employee fringe benefits, as well as to intensified competition. In addition increased imports of certain non-tire rubber products from producers in low-wage countries abroad were a factor.

But, while the picture for 1960 has not been one of clear cut blacks and whites, we can find many areas where new records underscored the promise of a continued high level of activity in 1961.

What were some of those records? U. S. production of 1,450,000 l.t. of synthetic rubber: U. S. consumption of 1,077,000 l.t. of synthetic rubber; U. S. exports of 350,000 l.t. of synthetic rubber; shipments of a record 68,500,000 passenger replacement tires. Again it should be noted that in the non-tire field, production of rubber products, though down slightly from 1959, continued to run substantially above the Federal Reserve Board Index of Total Industrial Production. Against the 1947-1949 base of 100, these segments of the rubber industry showed a production index of 179.2 as against the FRB figure for all production of 165.4 The production of these groups comprises industrial rubber products, belt and hose, packing, rubber footwear, flooring, rubber sundries, heels and soles, adhesives and molded and extruded goods of all types.

Against these background facts, we believe that the industry will do as well in 1961, if not somewhat better in certain areas of its widely diversified activities.

Ross R. Ormsby

President, Rubber Manufacturers Association, Inc., New York, N. Y.

We anticipate that the industry will sell approximately 127 million tires of all types in 1961.

George R. Vila

United States Rubber Co. will spend more than 53 million dollars in 1961 to intensify its research and development, and to modernize and expand its manufacturing and distribution facilities both here and abroad. Of the total, about 30 million dollars will be spent for modernization and expansion—an increase of 20 per cent compared with 1960.

Particular emphasis will be placed on quality control through automation of our tire production systems and improving the nationwide distribution of our tires. The company is now in a five year program which calls for the construction of more than 200 'tire shopping centers' by 1965. Approximately 40 new company stores are scheduled for construction in 1961 bringing the total number in operation to 80 by the end of the year. They will supplement our network of nearly 5,000 independent tire dealers.

We are also planning to expand our productton capacity for synthetic rubbers, plastics, chemicals and synthetic fibers which offer attractive profit potential for the company. This will be particularly true in foreign countries, where we are growing rapidly. U. S. Rubber expects to spend about 23 million dollars for research and development. A major portion of this research investment will be in the development of new manufacturing processes, new fibers and more versatile rubbers and plastics.

Sales in 1960 will be about 970 million dollars with earnings approximating $4.50 a share of common stock after deducting 37 cents a share for the company's Cuban investments. The 37 cents a share is after allowances for tax deductions and reserves of prior years. U. S. Rubber's two manufacturing plants and other facilities in Cuba were intervened by the Castro regime in September. U. S. Rubber expects sales in 1961 to be at about the same level as 1960, although an early business upturn would force a revision of the estimate.

In addition to U. S. Rubber's expansion plans for 1961, we note the company's interest, with the Borden Co., in construction of a 50 million dollar complex of chemical plants to convert hydrocarbons into plastics and other chemical products. The jointly-owned company, called Monochem, Inc., will build an acetylene plant and a vinyl monomer plant at Geismar, La. as a first step. Scheduled for completion in 1962, these units will cost more than 20 million dollars.

The company's Naugatuck Chemical division expects to increase its plastics sales from 5 to 10 per cent in the coming year. We expect that the average automobile in 1961 will use 30 pounds of plastics and this figure could double by 1965. U. S. Rubber has been in the vanguard of this trend with its vinyl materials and products and its tough rubber-plastic blends.

The company will increase its production of filament-wound cases for rockets, rocket motor insulators and rocket propellant binders, he said. A most promising consumer product is Vyrene, a new polyurethane thread, which will set new styles in both men's and women's fashions. An intensive world-wide expansion and promotion for this product is planned for next year.

U. S. Rubber and Witco Chemical Co., Inc. have formed a new company called Sto-Chem Ltd. to construct a $2,500,000 plant for the manufacture of synthetic rubber latex in England. The plant will have a capacity of more than 8,000,000 pounds of latex annually and is expected to go into operation in the fall of 1961.

For the rubber industry as a whole, sales for 1961 will probably be $6,200,000,000, substantially unchanged from the 1960 level, assuming the present recessionary tendencies have run their course by mid-year.

As for tires in 1961, we anticipate that the industry will sell approximately 127 million units of all types. Replacement tire sales should continue a healthy upward trend. The industry sold 69 million replacement passenger tires in 1960 and should sell a record 71 million in 1961. Truck and bus tires, both original equipment and replacement, should reach 14,600,000 in 1961, compared with 14,500,000 in 1960.

Domestic consumption of rubber is expected to reach 1,600,000 long tons in the coming year, an increase of 2½ per cent over 1960. Of this tonnage, 72 per cent will be synthetic, and 28 per cent natural rubber. The domestic rubber forecast included for the first time "substantial" quantities of the stereo-regular rubbers such as polybutadiene and polyisoprene—man-made equivalents of natural rubber that U. S. Rubber introduced in its truck tire manufacture two years ago.

The United States is still an enormous consumer of the world-wide supply of rubber, accounting for two-fifths of the total of four million long tons. Some 1,900,000 long tons will be used by the rest of the Free World in 1961, and approximately 400,000 long tons will be imported into the Soviet bloc.

George R. Vila

President, U. S. Rubber Co., New York, N. Y.

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We in the reclaiming industry have two great needs—to better educate the industry in the use of reclaim, and second, to modernize and mechanize our plants.

Henry L. Dixon

The year 1960 has been both disappointing and good for the reclaiming industry. It has been disappointing because all of our forecasts indicated a much greater consumption than we had. It has been good because there were approximately 280,000 long tons consumed. This is better than average reviewing the last 20 years. Based on 1,560,000 long ton consumption of new rubber, reclaim usage was approximately 17.9 per cent.

When we look at 1961 we see another total year about like 1960. In 1960, 152,000 long tons were consumed in the first half. However, in 1961 the large consumption should come in the last half of the year.

The year 1961 is being forecast as a year of hard sell and low profits. I believe that this provides the reclaiming industry with an opportunity to make some gains in the rubber industry. During the last 20 years there have been many new and glamorous rubber polymers produced for the rubber industry. There has been a clamor by both new and experienced compounders to use these polymers in the production of rubber products. As a result the art of compounding with reclaimed rubber has been pushed aside. The reasons that reclaim sold for 4½c per pound with crude rubber at 3-4/10c per pound in 1933 have been forgotten. 1961 should be a year to refresh those memories and for the rubber industry to start using more reclaim. It is up to us in the reclaiming industry to promote this.

We in the reclaiming industry have two great needs. The first is as explained above, to better educate the industry in the use of reclaim; and second, to modernize and mechanize our plants so that the price of reclaim can be more competitive with other rubber polymers.

Henry L. Dixon

President, Rubber Reclaimers Association, Inc., and General Manager, Reclaim, B. F. Goodrich Co., Akron, Ohio

Natural rubber growers are ready for competitive 60's with expanded replanting and research programs.

H. C. Bugbee

In the 60's rubber as a commodity enters the era of competition that has been on the horizon since the stereo rubbers first came into the picture some five or six years ago. During the last several years, natural rubber has done very well indeed, selling at a good price more rubber than we were producing.

During past years also, we have been putting ourselves in a position to keep selling our full production in the future. By replanting extensively we have lowered production costs. By consistently increasing both our replanting efforts and research expenditures, we are working towards bringing our costs lower still.

It is estimated that some 3,800,000 tons of all types of new rubber will be consumed during 1960. By 1965, industry economists forecast consumption of approximately 4,500,000 tons. Malaya's natural rubber industry is today concentrating on raising production so as to be able to account for its share of this over-all growth in demand.

In 1960, a total of some 2,060,000 tons of Natural Rubber was produced by the entire growing industry. By 1960, it will be producing some 2,810,000 tons. In 1960, Malaya accounted for the largest share of the year's production with some 715,000 tons; Malaya's contribution in 1970 is forecast at some 1,200,000 tons.

This will be high-yielding, low-production-cost rubber ear-marked from the time it was planted for hard competitive selling. As of the end of 1958, 42 per cent of Malaya's entire 3½ million acres of rubber were already replanted. The replanting program has since been stepped up; the objective is to achieve 100 per cent replanting in 10 to 15 years. If the program merely maintains its present rate, sometime between 1968 and 1973 Malayan acreage will be completely high-yielding.

Malayan research is moving along at an equally accelerated pace. Until March, 1953, the amount per pound allocated by the producers for research and development was ¼c Malayan; at that point it went to ½c. It remained here until February 1958, when it was raised to ¾c, tripling the original assessment. In 1952, the fund raised by the cess then collected was about $3,300,000 Malayan. In 1957, the last full year of the half-cent allocation, the fund reached approximately $7,500,000 Malayan. This year, the fund will run about $12,000,000 Malayan.

During the last part of the 50's, natural rubber was in a seller's market. At this point, the 60's would seem to be shaping up as a toughly competitive buyer's market. Fortunately, we are ready for it, and are making ourselves more so all the time.

The Malayan growers will be adding considerably to their production in the decade to come; this, of course, will be high-yielding rubber. The benefits of such production can best be measured by translating increased yields into cost terms. W. E. Klippert, vice-president, Goodyear Plantations, a practicing planter for 25 years, put it this way: "The cost of producing a pound of rubber on an 800 pound per acre yield is just half the cost where the yield is 350 pounds, and the cost for a 1,200 pound per acre yield is less than one-third."

A number of Malayan areas are producing more than 1,200 pounds per acre today. As replanting benefits accumulate, such yields will become more and more commonplace. Natural rubber looks to the future with confidence.

H. C. Bugbee

President, Natural Rubber Bureau, Washington, D. C.

For the ninth consecutive year, auto tire replacement sales in the United States should surpass the preceding year.

Russell DeYoung

Free World consumption of all rubber (natural and synthetic) should reach a new high of 3,760,000 long tons in 1960. Of the total amount of new rubber used in the United States in 1960, I expect a record 69 per cent to be synthetic—a gain of about 4 per cent over 1959. Consumption of synthetic abroad also continued to increase during the year.

For the ninth consecutive year, auto tire replacement sales in the United States should surpass the preceding year. We predict 1960 auto tire replacement sales will reach 69,000,000 units, with an all-time high of about 71,000,000 units forecast for 1961. We also expect replacement truck sales to probably reach 9,750,000 for 1961, approximately 200,000 more than 1960. Farm tire replacement sales should rise to a record 2,150,000 in 1961, against an expected 2,100,000 units in 1960.

Tire production capacity was increased world-wide in 1960 with construction by the industry of new plants and expansion and modernization of many existing manufacturing facilities. Goodyear, for example, increased production capacity abroad with new tire plants in Amiens, France, and Medicine Hat, Alberta, Canada. Completion of a modern tire plant near New Delhi, India, will highlight the 1961 expansion program.

Plant improvement programs will be initiated at several Goodyear plants overseas in 1961 to supply products for the important markets which make up the rapidly developing European economic community. Research activities continued at a high level throughout 1960 and covered the widest range of scientific exploration in history.

New synthetic rubbers and plastics, improved chemicals, tire cord fabrics and adhesives, coupled with the latest scientific testing and quality control equipment, raised the quality of products to a new high during the year. Significant progress was made in the advance of synthetic rubbers which offer advantages not found in natural rubber.

Goodyear recorded progress in the synthetic rubber field with the start of construction of a plant near Beaumont, Texas, to produce two revolutionary new stereo-synthetic rubbers. One of the new synthetics is called Natsyn (contraction of natural and synthetic). Made from isoprene, it duplicates the molecular structure of natural rubber and can be used as a complete replacement and as an extender for natural.

Goodyear's other new synthetic, known as Budene, is produced from butadiene and is used as an extender for the natural product. Both will be used in tires and industrial rubber products.

The Beaumont plant will cost more than $20,000,000, and represents the largest single capital expenditure for a plant in the company's history. The plant is scheduled to come on stream late in 1961. Each of the new synthetic rubbers will out-perform natural in many applications and will aid in freeing the industry from dependence upon natural rubber from abroad.

Continued growth in many of Goodyear's general product divisions which include chemicals and plastics, industrial goods, aviation products, packaging films and sheeting, metal products, foam cushioning, shoe products, flooring and counter tops, defense products and space projects, is expected.

Russell DeYoung

President, Goodyear Tire & Rubber Co., Akron, Ohio

We have confidence that the new year will see unprecedented sales of replacement tires. Best estimates indicate new replacement passenger tire sales in the United States alone will reach 71,000,000, an increase of 3.5 per cent.

Harvey S. Firestone, Jr.

The key word in our business vocabulary at Firestone for 1961 is confidence. Confidence in the rubber industry is justified. 1961 should see a continued expansion of synthetic rubber use which currently represents some 70 per cent of total new rubber consumed in the United States. Several new synthetic-naturals will become more available in 1961, including the Firestone Diene and Coral rubbers. These will be produced at new facilities at Orange, Texas, which will go into operation early in the new year.

World consumption of natural and synthetic rubber in 1960 reached some 3,785,000 tons, an increase of about 100,000 tons over the previous high of 1959. We expect that world rubber consumption will continue to rise. Estimates indicate consumption at the rate of 3,950,000 tons in 1961.

We also have confidence that the new year will see unprecedented sales of replacement tires. Best estimates indicate new replacement passenger tire sales in the United States alone will reach 71,000,000, an increase of 3.5 per cent. Truck and tractor tire sales should reach 11.4 million units.

These facts, plus the support of a strong gross national product of well over the five-hundred billion mark, a continuation of expanding personal income, increases in the population, increased government spending and numerous other favorable trends should lead the rubber industry to another record year in 1961.

During its most competitive years, the rubber industry has made its greatest progress. The most rapid advances in technology to meet marketing challenges have taken place when competition was the strongest.

We at Firestone have just reported the greatest sales and profits in our history for 1960, and we look forward to 1961 with great confidence because of our anticipated additional progress in research development, production, distribution and sales.

Harvey S. Firestone Jr.

Chairman, Firestone Tire & Rubber Co., Akron, Ohio

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Informed observers appear to be largely in agreement that economic conditions will begin to improve by the start of the second half of 1961 and that the level of economic activity for the year as a whole will be about on a par with that of 1960.

Greig B. Smith

Contrary to general expectation the pace of economic activity in Canada began to slacken early in 1960 and by mid-year it was evident that the Canadian economy was in the midst of a mild recession from the high level of 1959. Inevitably, the rubber industry was adversely affected and consumption of new rubber fell from the record 101,000 long tons in 1959 to about 90,000 in 1960, at which level it was approximately equal to consumption in 1956, the second-highest in the industry's history.

The advent of domestic compact cars failed to check the rise in imports of small British and European cars into Canada, but in spite of this and the unfavorable economic climate, original equipment tire sales rose slightly to about 2,165,000 units from 2,145,000 in 1959. On the other hand, replacement sales fell considerably from 6,458,000 units in 1959 to about 6,065,000 units in 1960 although the Canadian industry supplies the bulk of the replacement tires for imported as well as domestic vehicles. Consequently, total tire sales in the domestic market declined from 8,603,000 units to about 8,230,000, or about 4½ per cent.

Informed observers appear to be largely in agreement that economic conditions will begin to improve by the start of the second half of 1961 and that the level of economic activity for the year as a whole will be about on a par with that of 1960. For the rubber industry this indicates that sales of industrial rubber products in total will probably remain more or less the same as in 1960. Any significant change in the volume of footwear sales can only be for the worse unless the Government takes effective measures to check destructive Asiatic import competition. The tire division, however, anticipates a moderate improvement in total domestic sales with original equipment sales remaining at about the same level as in 1960 but replacement sales rising to approximately 6,460,000 units, raising total sales to 8,535,000 units, roughly equal to the record set in 1959.

Greig B. Smith

Manager and Secretary, Rubber Association of Canada, Toronto, Ont., Canada

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It is felt that the 1961 textile market will come in like a lamb and go out like a lion.

H. D. Ruhm, Jr.

According to signs already evident at the year's end, it appears likely that delivery of textiles to the rubber industry will become more important than price by the middle of 1961. While the total volume of woven fabrics sold to rubber manufacturers in 1960 is expected to be somewhat ahead of 1959, a marked decline started during the latter half of the year. This state of decline continues, and government sub-contract business is off substantially. The textile industry, evaluating this downward trend, has applied strict controls to mill inventories. Prices on future production have already reached a relatively low level. It is felt that the 1961 textile market will come in like a lamb and go out like a lion.

While cotton textiles continue to be of vital importance to rubber manufacturers, the steady growth in the use of man-made fibers continues. This is due in large part to new technological developments within both the rubber and the textile industries.

Fiber producers are continually introducing new fibers and modifications of existing ones. Olefins, for example, have been given very careful study and show considerable promise for rubber applications. As each new fiber becomes available in sample quantities, textile research and development staffs evaluate it to determine how it might be used to improve existing rubber products and others still in the development stage. By working closely together, textile and rubber technicians are able to take full advantage of these materials as soon as they are available in commercial quantities.

H. D. Ruhm, Jr.

President, Wellington Sears Co., New York, N. Y.

The bottom in new orders may have been reached, signalling the beginning of what should be an era of great growth.

In general, the year 1961 promises, at the least, moderate improvements in the rate of production, sales, and earnings for the tire industry, with most of the improvements coming in the second half.

M. G. O'Neil

The rubber industry's tire production in 1960 pushed over the 120-million unit mark for the first time in its history, but actually the shipment of 126.2 million units fell short of the forecast of the industry's statistical experts. A somewhat more realistic projection on the over-all outlook points to a 1961 performance at least equal to 1960's, with the possibility of a record demand for automobile replacement tires plus a stronger truck tire market supporting the forecast.

It is estimated that automobile replacement tire demands will top the 70-million mark for the first time . . . and may do it substantially. In 1960, a record of nearly 68.5 million automobile tires was shipped to the replacement market by the industry. The 1961 truck tire demand, which is unit-wise less than it was 10 years ago because of great technical developments in tire design and engineering, will be up in both original equipment and replacement tires as a result of the truck industry's increased tonnage.

As now projected, the demand for original equipment tires for automobiles will be less than in 1960, but if the nation's economy makes the expected marked recovery well before the end of 1961—and there are signs that it will—this picture could change quickly with a surge of new car orders. With the compact cars, which represent about 30 per cent of recent car production, coming into our replacement market, the dollar return will be somewhat less since the tires are smaller.

To meet its 1961 production, the industry will consume 1,560,000 long tons of new rubber, of which more than 70 per cent will be synthetic rubber manufactured in the United States. This will be a new high penetration of synthetics into rubber consumption.

In reviewing the General Tire picture specifically, our diversification into plastics, chemicals, rockets and entertainment, along with our rubber business, enabled us to register our greatest sales record in 1960 and to produce the company's second best earnings results. All of our divisions have been strengthened for the competitive challenge of 1961 with new facilities and new products and there is a good possibility that they will show improved sales and earnings in the coming year.

While it is obvious that there is no immediate business boom in the offing, the nation's economic future is assured with the built-in demands of an expanding population. In addition, the excesses which usually retard our economy, such as over balanced inventories, are not now prevailing.

One encouraging sign in the nation's economy now is the indication that the bottom in new orders may have been reached. This could signal the beginning of what should be an era of great growth—both for the rubber industry and the nation's other major industries.

M. G. O'Neil

President, General Tire & Rubber Co., Akron, Ohio

J. P. Seiberling

As I scan the business horizon, I see sunshine about six months away for the now cloudy economy and for the tire industry. The current "rolling readjustment" has hit hard at earnings from the tire replacement business in 1960. Tires are a good indicator of the state of the national economy. When business is booming, tires sell well—and vice versa. When money tightens, people put off buying tires. They "make do." They buy cheaper merchandise. They get along with what they have. If this is true of passenger tire buyers, it is doubly true of truck tire buyers. In addition, when business is off, less merchandise is shipped by truck and fewer new truck tires are sold.

All this will start to change late next spring, when "the natural surge of our country's growth" will combine with tire-consuming warm weather. The short term outlook is not favorable, in my judgment. Our industry, along with many others, has over-produced in 1960. We have too much merchandise on our shelves. But this will be worked out by late spring, when three things will happen: general business will pick up; in turn, the tire business will improve; and when current inventories are liquidated, economic pressure will force prices upward.

Today's over-supplied market is bringing consumers bargains they may never see again in passenger and truck tires. If tire prices today reflected the higher costs of labor and of some materials, they would be much higher. It is only the over-supply and the pressure of these goods on the market that is keeping them as low as they are.

Many economists predict a business upturn about the middle of 1961. At that time, they believe that demands of the continuing natural growth of our economy will stimulate recovery. I agree with this view, but I believe some industries, ours included, will feel some effects of this upturn even sooner—possibly by April or May. If the upturn develops into a continuation of the long-range rise in the economy, our country will demonstrate its ability to get through a major economic readjustment without the harmful effects of a depression.

I see some over-production in the early months of 1961, with demand catching up before the midyear point, and an increase of about 2.5 million units in passenger tire replacement sales over the 1960 level. Truck tire sales in the replacement market should rise by about 300,000 units.

When increased sales start to cut down inventories, tire prices should go up to reflect higher costs. For these reasons, tire manufacturers will get at least a measure of relief from narrow cost-price margins which have slashed replacement tire earnings in the third and fourth quarters. In general the year 1961 promises, at the least, moderate improvements in the rate of production, sales, and earnings for the tire industry, with most of the improvements coming in the second half.

J. P. Seiberling

President, Seiberling Rubber Co., Akron, Ohio

In 1961 . . . we shall beat the recession.

Stuart C. Covell

Last year began well. Production figures, judged from the consumption of raw rubber, had overtaken the 1955 peak. Everything seemed to point to a new surge ahead. Instead the year ended with a sharp setback. In my view the setback is largely artificial. It was precipitated in this country by Government action — high bank rate, credit squeeze, restrictions in the purchase facilities. By the same token it can be relieved in this country by Government action.

There remains, however, an element in the British setback which reflects a worldwide recession in trade. This, however, seems to me almost entirely nervous or political in origin. It has no genuine foundation in economic necessity. Even a moderate international détente in the months that lie ahead would be enough to turn the wheel and set our tires back on the road to prosperity. My message, therefore, for 1961 is that we shall beat the recession. And I hope soon.

Stuart C. Covell

Director, Federation of British Rubber and Allied Manufacturers, London, England.

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If 1961 turns out as the automotive industry and RMA expect, then we are due for a good year for the rubber industry and for sales of rubber chemicals.

J. S. Corrigall

Estimates of automobile production by the automotive industry indicate an increase in sales in 1961 over the 6,700,000 units estimated for 1960. This optimistic view has been tempered by Department of Commerce economists who believe that prospects for 1961 are 5,800,000 automobiles, a reasonably good year but considerably less than in 1960. However, in agreement with the automotive industry, the Rubber Manufacturers Association, knowing that 1960 estimates of rubber consumption of all grades will be about 1,550,000 long tons, predicts that 1961 will show an increase in rubber consumption to the amount of 1,600,000 long tons. If 1961 turns out as the automotive industry and RMA expect, then we are due for a good year for the rubber industry and for sales of rubber chemicals.

Nevertheless, a matter which concerns us for 1961 is increasing unemployment throughout all industry in the face of corporate financial statements which have been, all things considered, relatively good. We note that, discounting exceptional cases, the earnings of the larger rubber companies show a remarkable proportion of profits today coming from investments abroad where earnings are generally higher than in the United States. Industry investment in foreign countries over the last five years has grown rapidly as management has observed improved prospects for profits in these foreign ventures.

With relatively low duties, the automotive companies are able to import small cars from foreign plants to compete with their own and, following in this pattern, products made by rubber company foreign subsidiaries are now entering the country to compete at lower prices with the same products made here by the same companies.

Outside of rubber, this situation is having a serious effect on the clock, radio, machine tool and heavy basic industries and if the trend continues, unemployment cannot help but rise and purchasing power decline.

With respect to the rubber industry, foreign competition has already caused serious unemployment among shoe and mechanical goods manufacturers. Further, every rubber product made abroad and sold here not only increases unemployment in the rubber industry, but reduces the domestic market for rubber chemicals. If such competition continues—and it is our belief that it will—it is our expectation that, while export sales will increase, rubber chemical sales in the United States will fall off to some extent in 1961.

J. S. Corrigall

Vice-President, R. T. Vanderbilt Co., New York, N. Y.

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We hold to the conviction that the outlook for rubber is one of sound and assured growth as we enter 1961.

A. B. Leonard

We hold to the conviction that the outlook for rubber is one of sound and assured growth as we enter 1961. Not only do rubber goods rank high among the most essential items in our economy, but the relationship of new rubber consumption in the United States to personal consumption expenditures promises continued growth over the long term. Rubber consumption is favored throughout this decade, and beyond, via a dynamic change in the population composition and through technology associated with rubber chemistry.

Looking ahead and combining the projection of consumption expenditures with the relationship of transportation rubber, we estimate conservatively that in 1970 consumption of transportation rubber will be in the order of 1,220 thousand long tons. This represents approximately a 25 per cent increase above current experience. Evidence at this stage indicates that there will be an annual consumption of non-transportation rubber approaching 890 thousand long tons by 1970, or nearly 50 per cent above recent experience. Total new rubber consumption is expected to approach an annual rate of about 2,110 thousand long tons by 1970, representing an increase of about 32 per cent over recent experience.

Since there is an upper limit of sensible usage of many types of goods and services where rubber is used, we don't anticipate any arbitrary "five per cent growth rate" in rubber consumption. However, we do see changes occurring in the composition of our population which could affect our industries.

For one example, there is a phenomenal change in the fact that approximately 16.0 million people will pass to the 16

years and older age group during the ensuing five years. Another 15.0 million or so will do likewise between 1965 and 1970. This shift can be a tremendous thing for the rubber industry. Nearly every one of these teenagers will want a car. Whether every one of this group gets a car or not is something else, but the potential is large and so will be the desire.

In a few years there will be a large market in used compact cars. Not only has the compact influenced the consumer to consider lower cost in his choice of a new car, but it will effect a similar change in the used car market. Therefore, Phillips feels that the percentage of the total consumption dollar allocated to personal transportation is unlikely to be modified greatly during this period.

So much for what we regard as a favorable outlook for growth in rubber consumption. What kinds of rubber? As a pioneer and continuing innovator in the field of synthetic rubber, our company must give serious conjecture to the future of various types, including modifications effected by compounding with non-rubber materials.

The dictates of the market place will ultimately determine how much domestic capacity will be installed for producing *cis*-polydienes and how the market will be distributed among three competing commodities, that is, natural, synthetic *cis*-polyisoprene, and *cis*-polybutadiene. We expect that several hundred thousand tons of *cis*-polybutadiene capacity will have been constructed within a few years. Announced plans in this category already indicate a capacity of over 200,000 long tons will be installed by the end of 1962. Well over half is expected to be in production of *cis*-polybutadiene.

We believe it is logical to expect also that a long period of relative price stability is in the offing, compared to the typical volatility of natural rubber prices in the past. In any system of supply and demand which contains a large time lag, the price structure will tend to be under considerable leverage, either up or down. The natural rubber producers have been just as dismayed by price fluctuations on the downside as have consumers by fluctuations on the upside. *Cis*-polydiene plants can be built in substantially less than two years' time. As in most industries, some degree of nominal surplus capacity will eventually exist in order to accommodate peak demands. Few events are more embarrassing to the producer of an industrial product in a competitive market than not being able to fill promptly his customers' orders. The expected environment should temper the historical volatility of the natural rubber market.

Despite already imposing achievements, the field of polymer chemistry is still in its youth. Its horizon is unlimited. Another development unfolding in this field is the synthetic replacement of natural materials, such as gutta percha or balata, by *trans*-polybutadiene.

Meanwhile, we can depend on expanded consumption of proved and reliable SBR types. In terms of net polymer, U.S. production has increased roughly 80.0 per cent since private industry took over in the spring of 1955, compared to the mean of the three years prior to 1955. SBR enjoys an apparently stable percentage of 83.0 per cent of total synthetic rubber consumption. Cold rubber now comprises about 83.0 per cent of total SBR polymer. One-third of the SBR production is oil extended, excluding oil black masterbatch, which has been absorbing about 14.0 per cent of the net polymer. The percentage of non oil extended black masterbatch has continued to decline and currently lies between 2.0 and 3.0 per cent in terms of net polymer. In our opinion, the relatively low price of SBR and its oil extended types will assure SBR a major share of the synthetic market for an indefinite period.

While the rubber business is freely acknowledged to be a tough, competitive one, we feel strongly that our premises are valid in assuming that ten years from now, we can all look back and perceive that the Sixties really were golden after all. However, we won't be looking back. We will be forging ahead.

A. B. Leonard

Director, Rubber Chemicals Sales Division, Phillips Chemical Co., Bartlesville, Okla.

The year 1961 will have latex consumption influenced greatly by the general well being of the U.S.A. economy, with no new or spectacular uses on the horizon.

Arthur Nolan

The year 1960 brought to the broad spectrum of latices in the U. S. A. some major adjustments. Perhaps the most significant event during the year was the massive move taken by foam manufacturers to counter the competitive effects of alternate cushioning products, particularly urethane foams. Realignment within the latex foam industry resulted in production reductions. Some capabilities were discontinued or converted to other purposes. Latex foam's position in the cushioning product line is now less than its peak of a few years ago and may be somewhat healthier thereby. While this adjustment reduced latex consumption in foam products, other items, notably carpet back sizing and carpet coatings employing foam, increased their usage with an all-over latex consumption for the year moderately good.

Prices of products made from latex were erratic. Hevea latex itself suffered during most of the year because of high prices, reaching over forty-five cents, but recovered a good portion of its previous position later in the year when its price declined to around thirty-five cents. Latices used in paint declined two cents because of pressure from alternate polymers, not by reason of changes in raw material or manufacturing costs. Synthetic rubber latices prices remained essentially unchanged.

In the face of generally lower economic activity and unfavorable usage in foam, consumption of synthetic latices was at levels comparable to 1959. Nitrile and neoprene latices were consumed at the 1959 rate in the textile, paper, and adhesive fields. The SBR latices lost ground in foam despite major improvements in quality and utility, but gained substantially in textile usage.

While there are as yet no serious inroads into usages dominated by latices by reason of their aqueous colloidal properties, there are developments which appear to invade markets normally open only to latices. New polymers and techniques permitting such items as 100 per cent, or near 100 per cent, solid adhesives or non-aqueous liquid form, with faster processing properties, will doubtless grow and influence current latex markets.

The year 1961 will have latex consumption influenced greatly by the general well being of the U. S. A. economy, with no new or spectacular uses on the horizon. There will doubtless be pressures on prices; with no expectancy of monomer prices, volume rates or other cost economies enabling reductions; whereas other factors, such as increasing transportation costs, reduce possibilities for price reductions. Production capabilities appear adequate for all demands.

Competition between producers for segments of the latex market is so great that there will unquestionably be steady and significant improvements in quality and utility resulting from large research and development programs in numerous laboratory facilities devoted exclusively to latex and rubber investigations. With some markets shrinking, others leveling off, and with few new uses, efforts to increase a producer's share of markets now result largely from improved latices, improvements both in their polymer content and their rheological properties.

Arthur Nolan

General Sales Manager, Chemical Division, International Latex Corp., Dover, Del.

We are looking forward to further increases in sales and profits in 1961.

H. Shannon

It is difficult to speak authoritatively for the hard rubber sector of the rubber industry in the absence of separate statistics. However, the experience of American Hard Rubber Company in 1960 and its expectations for 1961 may parallel that of the hard rubber sector in general. Although the "soaring sixties" didn't get off to as soaring a start as many economists had predicted, 1960 was a good year for American Hard Rubber. Increases in sales and profits were recorded, resulting mainly from increases in our productive capacity and improved operating efficiency.

We are looking forward to further increases in sales and profits in 1961. The accomplishment of this forecast will require continued research and product development, and constant process improvement and operating cost reductions. The probable softness of the economy in the first half of 1961 will not make this task an easy one.

Salesmanship, individual selling, product promotion, advertising will be the key factors in determining how far and how fast our economy moves forward. They will determine where our economy will stand at the beginning of 1962.

H. Shannon

President, American Hard Rubber Co., Butler, N. J.

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We feel that the future of the industry which we serve is assured by the built-in demands of an expanding population.

F. L. Dawes

While our business is world-wide and there has been a sharp curtailment in export sales, we have shipped a satisfactory amount of machinery to foreign plants affiliated with or owned by American rubber and plastic manufacturers. During this year 1960, we have manufactured or are in the process of manufacturing a record volume of equipment for new plants now being established by the leading tire manufacturers in the United States. Our volume was augmented by large installations of aircraft brake and tire testing equipment. The value of new orders booked during this year will be considerably higher than the average annual sales for the past fifteen years of operation—a larger sales volume than any year, in that fifteen-year period, except 1956 and 1959.

In brief, sales have been satisfactory and, while there has been some decline in percentage of profit on volume, measured against prevailing economic conditions, 1960 will be a year of satisfactory accomplishments.

Domestic competition has been intense and it is reasonable to assume that it will continue to be so. There is a definite trend in international trade to export more goods and import less in the United States. This situation presents a real challenge, which can only be met by better methods of production and more economic designs that will permit us to offer our customers new and more useful products. Toward this end, we have made substantial capital expenditures, a major part of which were used for new, automatic, labor-saving machinery and increased office space which will house additional technical personnel.

While there is no immediate business boom in the offing we feel that the future of the industry which we serve is assured by the built-in demands of an expanding population and that our company will be in an excellent position to better serve this industry.

F. L. Dawes

President and General Manager, Adamson United Co., Akron, Ohio

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1961 is expected to be a year of temporary slackening in total U. S. demand for carbon black.

Michael W. Huber

In 1960 total U. S. consumption was approximately 1,500 million pounds. Total foreign Free World consumption was an estimated 1,230 million pounds. Total Free World consumption was roughly 2,730 million pounds. This was a new high for carbon black consumption.

I think 1961 will probably see a slight drop in total Free World consumption. Total U. S. consumption will be in the order of 1,440 million pounds. Foreign Free World consumption will approximate 1,283 million pounds, and total Free World consumption 2,723 million pounds.

Inasmuch as carbon black shipments depend heavily on rubber usage, the high level of demand for tires caused a 2 per cent increase in domestic carbon black shipments in the first six months of 1960 over the comparable period in 1959. In the last half of 1960, however, as tire production was cut back in line with shipments, carbon black shipments fell 6 per cent below the previous year. I think this weakness will continue into 1961. Original equipment tire production will reflect an approximate 10 per cent cutback in automobile production, and replacement tire shipments will fail to exceed the 1960 level. Not only will the effect of the business slowdown contribute to the postponement of replacement tire purchasing, but a smaller number of tires will be due for replacement in 1961, reflecting the low level of tire production in 1958. In short, I expect a 4 per cent decline in domestic rubber consumption from 1960 to 1961, which will be paralleled by a similar decline in domestic carbon black shipments.

In contrast to the domestic market, total 1960 exports from the United States expanded 8 per cent above 1959. Exports were stimulated by high rates of economic activity in nearly all countries of the world and by increasing usage of rubber. The outlook for carbon black exports in 1961 is that they will decline approximately 20 per cent to an estimated 400 million pounds. This will be due to the current expansion of capacity in many countries abroad.

In summary, 1961 is expected to be a year of temporary slackening in total U. S. demand for carbon black. This, coupled with the new capacity abroad, should require very little additional expansion in the carbon black industry in 1961. Supplies of carbon black world-wide should be ample.

Michael W. Huber

President, J. M. Huber Corp., New York, N. Y.

RUBBER AGE/VOL. 88, No. 4/January, 1961

Compounding

OIL RESISTANT Silicone Rubber

By ROBERT L. DAILEADER

Silicone Products Department,
General Electric Company,
Waterford, New York

SILICONE rubber has proved itself as a temperature resistant elastomer for more than a decade. Many physical properties of silicone rubber elastomers have been improved considerably during that time. Oil and fuel resistance, however, has presented a problem in some aircraft, automotive and electrical applications.

As a result of this experience, new types of silicone polymers have been developed which offer improved resistance to many oils. These oil resistant materials have not found universal acceptance because of their high cost, the difficulty of obtaining good bonds to other surfaces and the fact their heat resistance at temperatures above 400°F. has been somewhat inferior to general purpose grades of silicone rubber. Many fabricators, therefore, have sought ways of compounding the general purpose silicone rubbers to obtain maximum oil resistance, while retaining the other advantages of these materials.

Investigations of compounding and curing techniques were made to improve the oil resistance of general purpose silicone rubber. In addition, the effect of time and temperature of ASTM No. 1 and ASTM No. 3 oil immersion was studied. Finally, a general purpose compound was formulated to have good oil resistance—resistance to a variety of fluids is given for this compound. The object of this work was to provide silicone rubber fabricators with techniques for obtaining maximum oil resistance using general purpose silicone rubber reinforced gums.

Today the fabricator has available three general types of materials from which he can form finished parts. These may be described as pure gums, reinforced gums, and compounds. The silicone rubber gums require addition of fillers and curing agent before fabrication. The compounds are pre-mixed gums with fillers that require only curing agent (many contain this agent) before heat forming.

Reinforced gums are partially compounded materials containing some filler, which are primarily designed to take more filler and curing agent prior to fabrication. Reinforced gums are increasingly favored by fabricators due to inherently improved processing character, physical property advantage relative to pure gums, and natural versatility relative to pre-mixed compounds. Because of this versatility, General Electric SE-404 reinforced gum was selected as the base material for this study. SE-404 is a general purpose material based on a methyl-vinyl silicone polymer containing a primed silica filler.

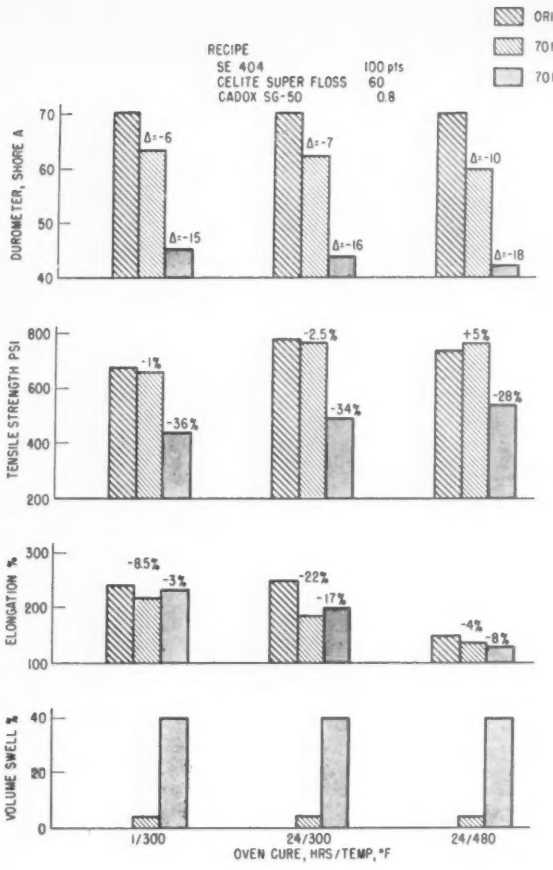

FIG. 1—Effect of oven cure on oil resistance.

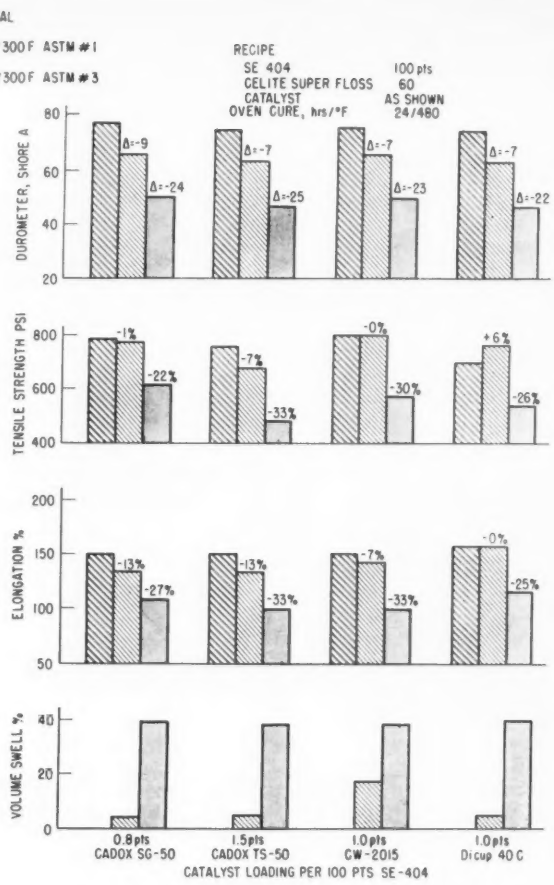

FIG. 2—Effect of catalyst type on oil resistance.

To test the effects of these variables on oil resistance, ASTM Method D471-J7T was used. Measurements of tensile strength, ultimate elongation, hardness and volume swell before and after exposure to the various liquids were selected as the criteria for oil resistance.

The base formulation used in this work and standard test conditions were as follows:

Base Recipe

SE-404	100 parts
Celite Super Floss	60 parts
Cadox SG-50	0.8 parts

Press Cure, min. at degrees F.	10/270
Oven Cure, hrs. at degrees F.	24/480

Oil Age, hrs. at degrees F.	70/300 in ASTM No. 1
hrs. at degrees F.	70/300 in ASTM No. 3

To study the effect of each variable, changes in the above recipe and test conditions were made one at a time, while all other variables were held fixed at the level indicated above.

Oven cures of 1 hour at 300°F., 24 hours at 300°F., and 24 hours at 480°F. were studied for their effect on the oil resistance to ASTM No. 1 and ASTM No. 3 oils of the base recipe. Test results are shown in Figure 1 and tabulated in Table I. While changing the degree of oven curing produces a change in the physical property profile of the compound prior to oil immersion, the oven cures studied show no marked effect on the percentage of retained physicals or the degree of volume swell.

Three levels of Cadox SG-50, Cadox TS-50, CW-2015 and DiCup 40C were evaluated for any effect on the oil resistance of the base SE-404/Celite Super Floss formulation. In the tests using DiCup 40C and CW-2015, it was necessary to mold the test slabs for ten minutes at 340°F, prior to oven curing because of the higher activation temperature required to effect a cure with these catalysts. Complete test data for these formulations is shown in Table II.

Figure 2 compares the four curing agents at their typical levels in the base recipe. No significant differences in the retained physicals after oil aging is

evident among the four catalysts. It is concluded that catalyst type has no apparent effect on oil resistance.

To study the effect on catalyst level, the normal amount was arbitrarily halved and doubled in the standard formulation. The data in Table II shows that while catalyst level can alter the physical properties of the rubber prior to oil immersion, no marked changes in the retained physicals occur as a result of varying the amount of curing agent.

Several loadings of six different silica fillers were mixed with SE-404 to evaluate their effect on oil resistance. Results of these tests are given in Tables III and IV. The correlated data from these tests is shown in Figure 3 at equal filler loadings and in Figure 4 at equal durometers.

Loaded with 25 parts of the various fillers, resistance to aging in low aromatic content ASTM No. 1 oil was approximately equivalent for all fillers. In the more aromatic ASTM No. 3 oil, the retained physicals of the Celite filled compounds were superior to compounds based on the other fillers.

When the formulations are compared at equal durometers, the physicals on aging in ASTM No. 1 oil again appear about equal, except for the Santocel CS filled compound which is poorer than average. In ASTM No. 3 oil, the Celite fillers retain their original properties better than do the other fillers.

Celite Super Floss and Celite 350 filled compounds offer the best resistance to ASTM No. 1 and No. 3 oils. Although Neo Novacite filled compounds perform well in ASTM No. 1 oil, their performance in ASTM No. 3 oil is inferior to the Celite fillers. Compounds containing reinforcing type fillers have less oil resistance, with Santocel CS filled compounds being poorest. For a given filler type, the higher the loading the better the compound resists changes in physical properties due to oil immersion.

To study the effect of time and temperature, three temperatures and four immersion times for periods up to one week in both ASTM No. 1 and ASTM No.

TABLE I—EFFECT OF OVEN CURE ON OIL RESISTANCE

Recipe			
SE-404	100 parts		
Celite Super Floss	60 parts		
Cadox SG-50	0.8 parts		
Oven Cure, hrs/°F.	1/300	24/300	24/480
Cured Physicals			
Hardness, Shore A	70	70	70
Tensile, psi	690	770	720
Elongation, %	250	260	140
Tear, pi	85	90	65
Oil Aged 70 hrs/300°F., ASTM No. 1			
Hardness, Shore A	64	63	60
Tensile, psi	690	750	760
Elongation, %	220	180	140
Volume Swell, %	5	4	5
Oil Aged 70 hrs/300°F., ASTM No. 3			
Hardness, Shore A	45	44	42
Tensile, psi	440	510	130
Elongation, %	240	200	130
Volume Swell, %	40	41	40

TABLE II—EFFECT OF CATALYST TYPE AND LEVEL ON OIL RESISTANCE

Recipe												
SE-404	100	100	100	100	100	100	100	100	100	100	100	100
Celite Super Floss	60	60	60	60	60	60	60	60	60	60	60	60
Cadox SG-50	0.4	0.8	1.6	—	—	—	—	—	—	—	—	—
Cadox TS-50	—	—	—	0.75	1.5	3.0	—	—	—	—	—	—
CW 2015	—	—	—	—	—	—	0.5	1.0	2.0	—	—	—
DiCup 40C	—	—	—	—	—	—	—	—	—	0.5	1.0	2.0
Oven Cure: 24 hours at 480°F.												
Cured Physicals												
Hardness, Shore A	74	73	75	66	70	78	60	74	72	73	72	75
Tensile, psi	840	790	900	630	750	990	400	800	710	790	710	690
Elongation, %	130	150	140	160	150	130	230	150	170	150	160	140
Tear, pi	70	65	70	60	60	80	60	80	85	75	70	70
Oil Aged 70 hrs/300°F, ASTM No. 1												
Hardness, Shore A	67	66	68	60	64	70	56	68	65	65	64	67
Tensile, psi	850	780	870	590	690	870	620	800	790	750	750	790
Elongation, %	150	130	130	150	130	120	190	140	160	140	160	130
Volume Swell, %	6	5	5	6	6	5	6	18	4	6	6	6
Oil Aged 70 hrs/300°F, ASTM No. 3												
Hardness, Shore A	50	50	49	42	47	51	41	50	48	50	48	52
Tensile, psi	680	610	650	440	500	670	400	560	480	590	520	580
Elongation, %	130	110	120	140	100	110	150	100	120	120	120	100
Volume Swell, %	50	39	37	40	38	35	40	38	39	40	40	38

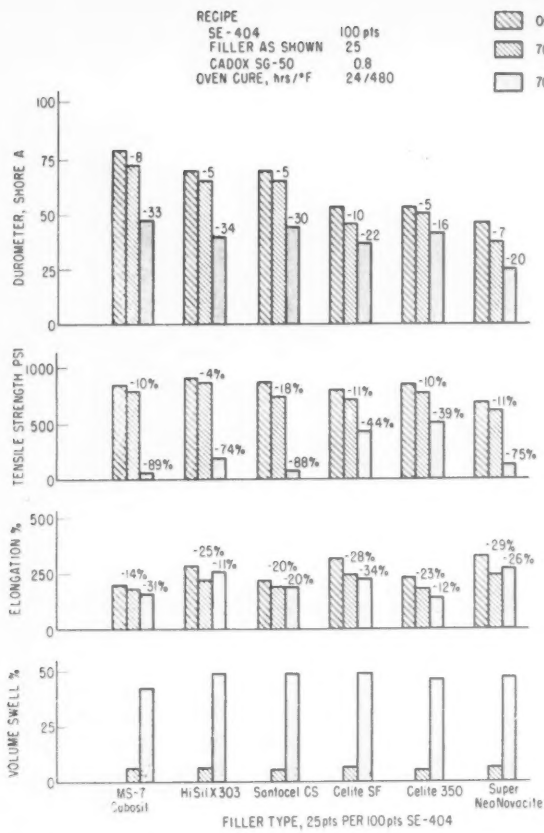

FIG. 3—Effect of filler type on oil resistance at equal loadings.

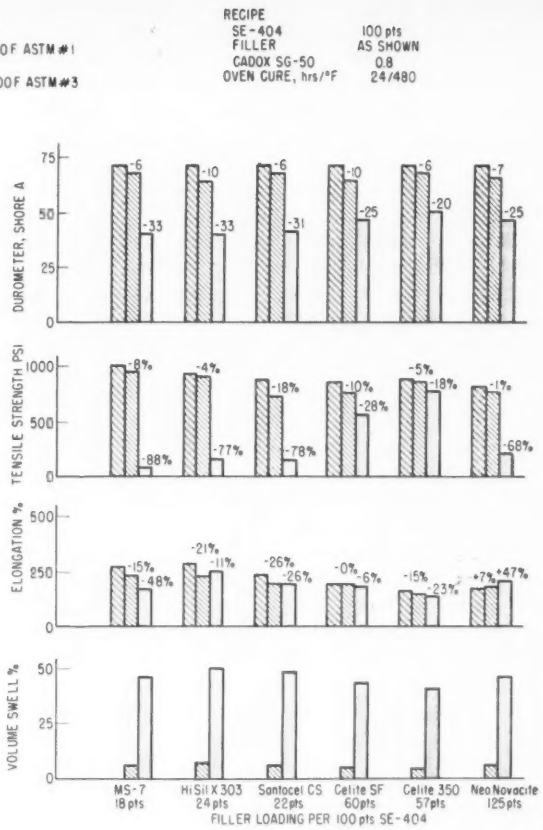

FIG. 4—Effect of filler type on oil resistance at 70 durometer.

TABLE III—EFFECT OF FILLER TYPE AND LOADING ON OIL RESISTANCE

	Recipe								
SE-404	100	100	100	100	100	100	100	100	100
Cabosil MS-7	—	14	22	32	—	—	—	—	—
HiSil X303	—	—	—	—	10	30	—	—	—
Santocel CS	—	—	—	—	—	—	15	30	50
Cadox SG-50	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Oven Cure: 24 hours at 480°F.								
	Cured Physicals								
Hardness, Shore A	38	66	76	85	56	75	64	75	86
Tensile, psi	670	1100	880	650	1120	850	780	850	800
Elongation, %	410	340	200	100	380	240	260	170	100
Tear, pi	45	75	100	100	85	75	95	95	110
	Oil Aged 70 hrs/300°F, ASTM No. 1								
Hardness, Shore A	33	56	73	80	50	72	58	73	81
Tensile, psi	530	1050	860	590	970	840	670	670	750
Elongation, %	270	300	180	100	290	180	220	130	60
Volume Swell, %	7	10	8	7	10	6	6	7	5
	Oil Aged 70 hrs/300°F, ASTM No. 3								
Hardness, Shore A	20	30	40	59	28	40	25	50	65
Tensile, psi	180	100	100	430	120	260	110	250	370
Elongation, %	230	200	100	120	290	200	200	150	50
Volume Swell, %	49	52	42	38	55	43	50	37	44

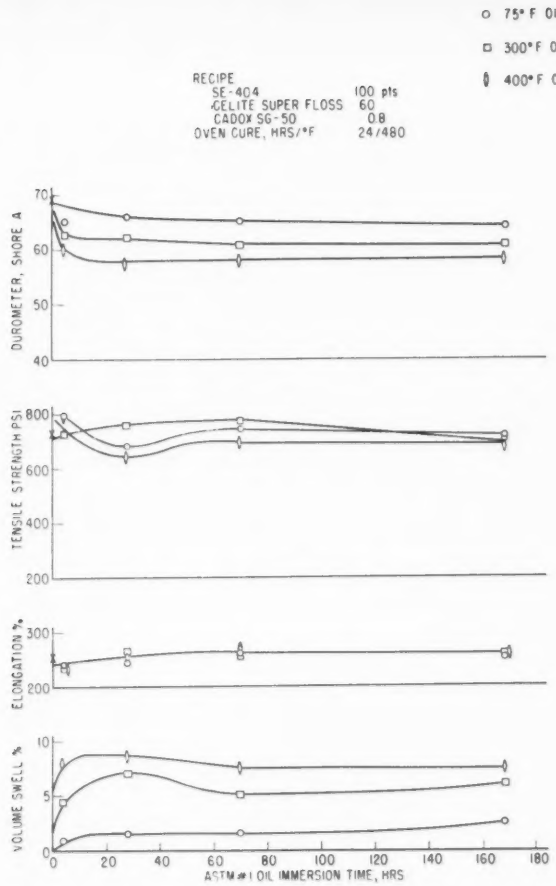

FIG. 5—Effect of oil temperature and immersion time on oil resistance to ASTM No. 1 oil.

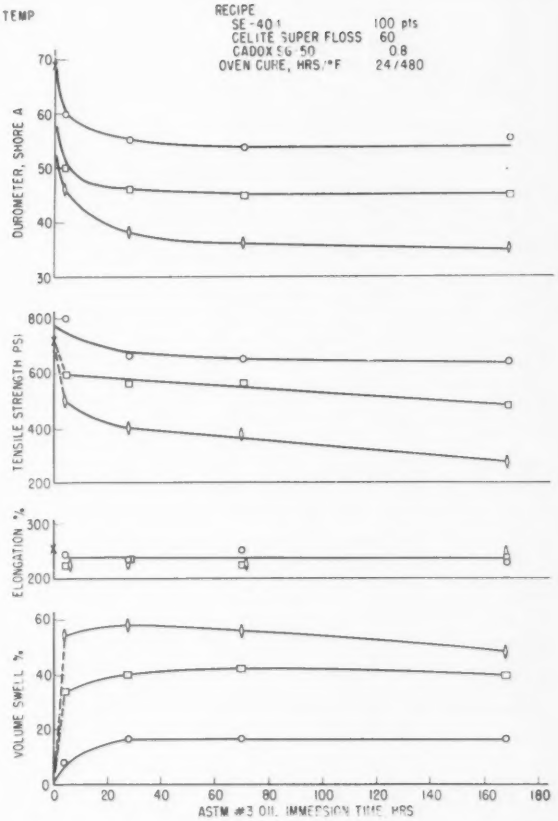

FIG. 6—Effect of oil temperature and immersion time on oil resistance to ASTM No. 3 oil.

TABLE IV—EFFECT OF FILLER TYPE AND LOADING ON OIL RESISTANCE

	Recipe								
SE-404	100	100	100	100	100	100	100	100	100
Celite 350	30	60	100	—	—	—	—	—	—
Celite Super Floss	—	—	—	30	60	90	—	—	—
Neo Novacite	—	—	—	—	—	—	60	110	200
Cadox SG-50	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Oven Cure: 24 hours at 480°F.								
	Cured Physicals								
Hardness, Shore A	60	73	81	55	68	77	55	68	86
Tensile, psi	870	880	690	810	730	780	770	770	660
Elongation, %	180	140	110	300	160	120	250	170	110
Tear, pi	65	65	85	65	70	70	70	60	80
	Oil Aged 70 hrs/300°F, ASTM No. 1								
Hardness, Shore A	55	68	77	48	60	70	50	60	83
Tensile, psi	800	830	920	710	740	770	740	760	690
Elongation, %	160	110	90	220	150	110	220	170	80
Volume Swell, %	6	6	5	8	6	6	7	8	4
	Oil Aged 70 hrs/300°F, ASTM No. 3								
Hardness, Shore A	42	50	55	37	45	52	35	35	65
Tensile, psi	580	710	600	480	520	630	170	260	410
Elongation, %	150	120	80	210	140	110	270	230	90
Volume Swell, %	44	37	17	49	38	35	47	34	24

TABLE V—EFFECT OF TIME AND TEMPERATURE ON OIL RESISTANCE

Recipe	
SE-404	100 parts
Celite Super Floss	60 parts
Cadox SG-50	0.8 parts

Cured Physicals, 24/480	
Hardness, Shore A	68
Tensile, psi	720
Elongation, %	150

	ASTM No. 1 Oil			
75°F.	4 hrs.	24 hrs.	70 hrs.	168 hrs.
Hardness, Shore A	65	66	65	64
Tensile, psi	790	690	760	720
Elongation, %	140	140	160	150
Volume Swell, %	1	1.5	1.5	2.5
300°F.				
Hardness, Shore A	63	62	61	61
Tensile, psi	730	750	770	720
Elongation, %	130	170	150	160
Volume Swell, %	4.5	7	5	6
400°F.				
Hardness, Shore A	60	57	58	58
Tensile, psi	780	650	710	690
Elongation, %	130	160	170	160
Volume Swell, %	8	8.5	7.5	7.5

TABLE VI—EFFECT OF TIME AND TEMPERATURE ON OIL RESISTANCE

Recipe	
SE-404	100 parts
Celite Super Floss	60 parts
Cadox SG-50	0.8 parts

Cured Physicals, 24/480	
Hardness, Shore A	68
Tensile, psi	720
Elongation, %	150

	ASTM No. 3 Oil			
75°F.	4 hrs.	24 hrs.	70 hrs.	168 hrs.
Hardness, Shore A	60	55	54	55
Tensile, psi	800	670	670	640
Elongation, %	140	130	150	130
Volume Swell, %	9	15	16	17
300°F.				
Hardness, Shore A	50	46	45	45
Tensile, psi	590	560	560	470
Elongation, %	120	130	120	140
Volume Swell, %	34	40	42	40
400°F.				
Hardness, Shore A	46	38	36	35
Tensile, psi	500	400	390	270
Elongation, %	120	120	120	160
Volume Swell, %	53	57	55	44

3 oil were used. Results are shown in Figures 5 and 6. The tabulated data are given in Tables V and VI.

Referring to Figure 5 it can be seen that the level of physical properties does not change appreciably beyond 70 hours immersion in ASTM No. 1 oil at any of the test temperatures. The higher the oil temperature the greater the rubber degradation. Elongation does not appear to be affected by oil immersion at any temperature.

The more aromatic ASTM No. 3 oil is more severe in its deterioration of the base formulation. As shown in Figure 6, increasing the oil temperature markedly reduces durometer and tensile strength. Elongation is not affected by oil temperature or immersion time. While durometer, volume swell, and tensile strength do not change appreciably beyond 70 hours immersion, tensile strength continues to show a gradual decline through 168 hours.

Immersion Tests

Immersion tests in various fluids and solvents were made on the basic formulation and the changes in physical properties are reported in Tables VII and VIII. From these data it is evident that changes in hardness and volume swell are not reliable measures of how other physical properties will be affected. Within each type of fluid or solvent group, a broad range of retained properties can be found. It is important that test data on the particular oil be measured, since it is not possible to predict reliable data within a given oil grouping.

In this study a typical formulation based on a general purpose reinforced gum, SE-404, was used to investigate several variables thought to possibly influence oil resistance. It was intended that the results would provide silicone rubber fabricators with leads they could employ in compounding for maximum oil and fuel resistance. The following conclusions are drawn from this study.

Conclusions of the Study

1. No significant changes in oil resistance result between oven cures of 1 hour at 300°F., 24 hours at 300°F., and 24 hours at 480°F.

2. Catalyst type and variations in the catalyst level do not affect the percentage of retained physicals.

3. Semi-reinforcing fillers offer better oil resistance than the reinforcing type. Among the semi-reinforcing type, the Celite fillers are best.

4. Increasing oil temperature and immersion time results in increased deterioration of the rubber. Retained physicals after ASTM No. 1 and ASTM No. 3 immersion remain fairly level beyond 70 hours exposure.

5. A profile of retained properties after exposure to a variety of fluids and solvents is given in Tables VII and VIII. Hardness change and volume swell were found to be an unreliable tool for predicting other retained physical properties.

TABLE VII—RESISTANCE TO FLUIDS AND SOLVENTS

Recipe

SE-404	100 parts
Celite Super Floss	60 parts
Cadox SG-50	0.8 parts

Cured Physicals, 24/480

Hardness, Shore A	68
Tensile, psi	760
Elongation, %	160

Solvents	Test Conditions time/temp	Retained Physicals H	T	E	ΔV
Water	168/75	68	630	150	<1
	70/212	70	640	140	1
Steam	22/338	64	300	100	1
Ethanol	168/75	63	580	150	7
Isopropanol	168/75	54	570	130	23
Acetone	168/75	54	560	130	25
Toluene	168/25	44	480	70	126
Trichloro-ethylene	168/75	40	290	50	145
Carbon tetrachloride	168/75	50	290	50	161
Oils and Lubricants					
ASTM #1	70/300	63	700	150	6
ASTM #3	70/300	45	500	140	39
Anderol L-774	70/400	- - - - Dissolved - - - -			
Turbo 15	70/400	- - - - Dissolved - - - -			
Fuels					
JP-4	168/75	35	480	80	136
JP-5	168/75	44	490	70	106
JP-6	168/75	35	460	80	131
Avgas	168/75	48	440	70	149

TABLE VIII—RESISTANCE TO FLUIDS AND SOLVENTS

Recipe

SE-404	100 parts
Celite Super Floss	60 parts
Cadox SG-50	0.8 parts

Cured Physicals, 24/480

Hardness, Shore A	68
Tensile, psi	760
Elongation, %	160

Transmission Fluids	Test Conditions time/temp	Retained Physicals H	T	E	ΔV
Texamatic A	70/300	40	380	150	36
AQ 351	70/300	48	560	120	35
WA 218	70/300	48	590	140	36
Hydraulic Fluids					
OS-45	70/300	47	480	110	54
Oronite 8200	70/300	43	480	90	83
Oronite 8515	70/400	- - Too Weak To Test - -			
Univis J-43	70/250	50	510	80	102
Skydrol 500	70/250	- - Too Weak To Test - -			
Versilube F-50	168/75	52	530	110	51
Extreme Pressure Lubricants					
Hypoid EP (90 cut)	70/300	35	250	150	10
Silicone Fluids					
SF-96 (1000)	168/75	55	670	140	18
Viscasil (100,000)	168/75	60	690	160	6

Filler choice, oil type and oil temperature emerge as the significant variables to be considered in formulating for maximum oil resistance. Of course, design of any finished part so as to minimize exposure to particularly severe fluids will always influence the usefulness of a particular compound in any application. However, consideration of these conclusions on the part of a fabricator should enable him to utilize better the lower cost, superior heat resistance and better bondability of general purpose silicone rubbers over materials which offer only better oil resistance.

Coming in February . . .

Quality Control in the Rubber Industry

By SIMON COLLIER, formerly director of quality control for the Johns-Manville Corporation and currently chairman of ASTM Committees on Quality Control (E-11) and Rubber and Rubberlike Products (D-11), and EDWARD REYNOLDS, quality control consultant.

The most comprehensive series of articles prepared to date specifically designed for the rubber manufacturing industry. It will cover concepts, personnel, organization, statistical techniques and the over-all philosophy of quality control. The series will help all rubber manufacturers — large and small—to better understand and to adopt the latest developments in the quality control field.

The Vulcanized-on-Sole Process:

CONCLUSIONS

Special studies and conclusions of an informative four-part series

By A. W. NICONCHUK
United Shoe Machinery Corp., Beverly, Mass.

LET us now enumerate conclusions for the facts presented in Parts 1, 2 and 3 of this series. From the compounding studies discussed in Part 2, we can state that after eighteen experimental runs with a maximum batch size of 135 pounds, it was found necessary to follow these procedures in order to reproduce suitable natural rubber soling stocks:

(1) Fast curing soling stocks should not exceed 50 Mooney for processing safety.

(2) Prebreakdown of rubber on mill results in better quality soling stock.

(3) Sulfur and accelerators must be omitted from Banbury mixing (particularly with an inadequate Banbury cooling system).

(4) When milling sulfur and accelerators into "hot" stocks, the mill temperature should be maintained below 200°F.

(5) Proper dispersion of sulfur on a 40 inch mill requires six minutes with rolls set at ⅛ inch.

(6) Banbury mixed stocks should be cooled to a minimum of 100°F. before addition of sulfur and accelerators.

(7) Unless completely removed prior to vulcanizing, the use of anti-tack agents, such as soaps and stearates, is prohibitive since such materials interfere with proper knitting of sole and heel pieces. We prefer the use of polyethylene liners for uncured slabs, thereby eliminating the need of dusting agents.

(8) Soling stock removed directly from the rubber mill should be cooled to ambient temperature before stacking to prevent precure.

(9) Calendering of soling stocks to uniform thickness is essential to uniformity in cured soles.

(10) Masterbatching of sulfur/accelerators and blending with Banbury masterbatch on rubber mill (below 200°F.).

Our evaluation of suitable soling stocks was determined by actual wear test performance. Tables I and II show soling stocks, developed by United Shoe Machinery Corporation, that performed exceptionally well on wear tests. Table III lists some of the physical properties.

We also conducted several special studies in our research on the vulcanized-on-sole process. To determine the degree of heat available at the rubber/leather interface, a heat transfer study was done under actual molding conditions. This information was needed for the following reasons:

(1) There was poor hot bond strength between the rubber sole and the leather upper. This bond is the degree of attachment of the sole to the upper immediately after the end of the curing cycle when bottomed shoes are removed. We noted that an improperly bonded sole, despite favorable upper preparation, had a tendency to creep away from the welt plate line. This distorted the sole extensions when the molds opened. In some cases, when sticking to molds occurred, the sole became dislodged from the upper. This condition was quite pronounced when thermoplastic adhesives were used.

(2) Hot or cold bonds were inadequate with natural rubber, cork filled, soling stocks during field trials.

(3) Hot or cold bonds were inadequate with synthetic rubber soling stocks, particularly the nitrile types.

Thermocouples Attached to Shoe

The heat transfer study was performed with the aid of a potentiometer, several thermocouples and a selector switch. The thermocouples were attached to the shoe upper at various points midway in the lasted margin, as shown in Figure 1. The shoe upper was slotted to accommodate the wires without damage by welt plates.

Time/temperature curves were plotted under varying conditions with various soling stocks. The most significant points of interest are shown in Figure 2.

TABLE I—TRANSLUCENT SOLING STOCKS

(Developed by United Shoe Machinery Corporation)

NBR (Hycar 1052)*	100.0	—	—	—	—
SBR (Plioflex 1778)	—	100.0	—	—	—
NBR (Hycar 1203)	—	—	100.00	—	—
NBR (Paracril OZO)	—	—	—	100.0	—
NBR (Hycar 1432)	—	—	—	—	100.0
PVC	—	—	—	—	44.3
HiSil 233	50.0	50.0	35.00	35.0	50.0
Cumar R-29	15.0	—	—	—	—
Coray 40	—	30.0	—	—	—
Arneel SD	10.0	—	10.50	10.5	15.0
D O A	—	—	15.00	15.0	22.3
Stearic acid	1.0	1.0	0.70	0.7	1.0
Stabilizer	—	—	—	—	.4
Zinc Oxide (Protox 169)	1.0	1.0	1.70	.7	1.0
Paraffin	1.0	1.0	0.70	.7	1.0
Plasticizer SC	10.0	—	—	—	—
Wingstay ST	—	1.0	—	—	—
Wingstay S	1.0	—	—	—	—
Superlite	—	—	0.70	.7	1.0
Sulfur	2.0	2.0	1.75	2.0	2.6
Captax	1.0	1.0	2.00	—	3.0
Altax	—	1.0	—	—	—
Methyl Tuads	0.3	0.3	.30	—	.4
Methyl Zimate	—	—	—	1.5	—
Piperidine Sieves (CW 1015)	3.3	3.3	3.30	—	5.0
Bismate	—	—	—	0.3	—
Diethylene Glycol	—	4.7	—	—	—
RBH Red Disp.	0.2	0.2	.30	—	—

* Goodyear Chemigum N-6, N-600, Goodrich Hycar 1041, 1042.

Key information noted included: (a) An initial 5 to 6 minute curing time required to reach 220°F. (b) Maximum temperature reached at end of 12 minutes curing cycle was 240° to 250°F. (c) A slight rise in temperature *after* molds opened. (d) Four to 5 minute interval to dissipate heat to 220°F. (e) The dwell from 220°F. on the rising curve, to 220°F. on the falling curve is approximately 12 minutes. This span of the cure is known as the Critical Area.

Significance of Critical Area

The significance of this critical area rises from the fact that both our developed soling stocks and adhesives show a fairly "tight" cure in 12 minutes at 220°F. Temperature in excess of 220°F. is added insurance toward optimum cure. At the end of the curing cycle (12 minutes) when the molds open, both the soling stock and the adhesive have reached such an advanced state of cure that even mold sticking, if occurring, has no detrimental effect on the bonded outsole. We recommend cooling to ambient temperature subsequent to removal of shoe from foot form before bond testing. Our many tests on quality of bond revealed no significant difference between a 30 minute and a 24 hour test. Quality of bonds and test methods was discussed in Part 3, "Adhesives."

We determined the thermal condition at the rubber/leather interface by increasing the temperature at the main heat source, the bottom mold, from 325°F. to 350°F. This is shown in Figure 3. The thermal gain was approximately 10°F. A ten degree heat differential at this critical interface can spell the difference between adequate bonding and premature failure. Heating sole molds to 350°F. is not recommended nor necessary for natural rubber soling stocks. With synthetic rubber soling stocks, high molding temperatures were essential to a complete cure.

Side and Bottom Molds

Individual contribution of the side molds and bottom mold to the curing of the outsole is illustrated in Figure 4. Due to the limited contact area, the side molds cure only the sole extensions as shown in an earlier cross section diagram (approximately ¼ inch).

TABLE II—SUITABLE SOLING STOCKS FOR VULCANIZED-ON-SOLE PROCESS

(Developed by United Shoe Machinery Corporation)

	1296-38-1 Non-Mark Black	1296-38-3 Brown	1327-17	1322-15-5 (Oil Res.)	1322-25-1 (Oil Res.) Long Wear
Smoked Sheet	100	100			
SBR Rubber*			100		
NBR Rubber**				100	
NBR/Vinyl***					70/30
Plastone	10	10			
Mineral Rubber	3	3			
Pine Tar	2	2			
Stearic Acid	1	1	1.3	1.0	
Reogen	1	1	4		
Silene EF	45	45	50		
Dixie Clay	45	45			
Lt. Mag. Carb.	10	10			
Pliolite S6B	5	5	25		
Reclaim Rubber	5	5			
Protox 169	5	5	6	5.0	3.5
Agerite Powder	1	1			
Agerite Hypar	1	1		1.0	.7
Paraffin Wax	2	2	1.3	2.0	1.4
Diethylene Glycol	2.7	0	3.0		
Altax	1.5	1.0	1.5		
Captax	0.5	1.0	.5		
Me Tuads	0.3	0.5	.3		
Sulfur	2.5	1.5	2.3	2.0	1.4
HiSil 303			12.3		
Roxtone 180			10.0		
Cumar R-29			10.0	15.0	10.5
Agerite Stalite			1.3		
Red Oxide		4.0	4.0	3.0	2.1
Carbon Black	0.5	0.25	0.5	0.5	0.35
Polybutene 32			2.7		
HiSil 233				60.	42.0
Arneel SD				10.	7.0
Agerite White				1.	0.7
Durex 12687				15.	10.7
Methyl Zimate				1.5	1.5
Cumate				0.2	0.2
Dioctyl Adipate					15.0
Ferro 1820					0.3
Sulfasan R		1.5			

* Goodyear Plioflex 1502, ** Goodyear Chemigum N-6, N600, Goodrich Hycar 1041, 1042, *** Includes all of these.

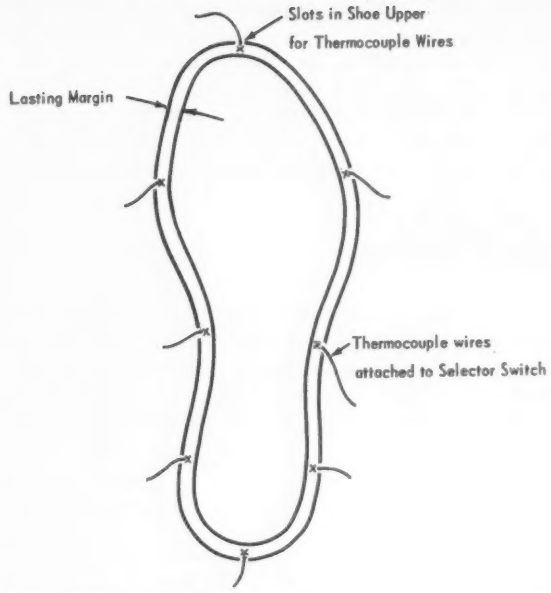

FIG. 1—Wires were attached to the shoe for the heat transfer study.

This accounts for the low reading of the thermocouple positioned midway on the lasted margin and just beyond the cured portion of the sole extension.

Reliance on sole mold alone shows temperature drop approximately 25°F. The conductivity curve rises to the 220°F. point in approximately the same manner and then flattens out. Therefore, accuracy of the data is questionable due to indeterminable heat losses to adjacent cold surfaces.

Figure 5 shows the degree of heat transfer in a particular neoprene soling stock. Despite the high degree of heat transfer, this soling stock was considerably slower curing than the USMC stocks.

Thermal Conductivity Study

The key points drawn from this thermal conductivity study are:

(1) The temperature reached at the interface of the rubber and leather (cement line) must be sufficient to cure the adhesive during the curing cycle, including cooling period.

(2) The ideal condition exists when both the soling stock and the adhesive cure during the vulcanizing and cooling cycle. Either the sole or adhesive must show a degree of cure in order to effect a hot bond.

(3) The rate of heat transfer determines the curing conditions at the interface. Cure systems for both the soling stock and the bonding adhesive must be formulated around the temperature conditions at the cement line.

(4) The rate of heat transfer through the soling stock varies directly with the temperature of the bottom mold. Higher sole temperature will result in higher temperature at the interface of rubber and leather. This condition can be gained at the expense of overcure at the sole tread which in turn reduces wear qualities.

(5) Synthetic rubber soling stocks can withstand higher curing temperatures than natural rubber with no detrimental effects to wear quality.

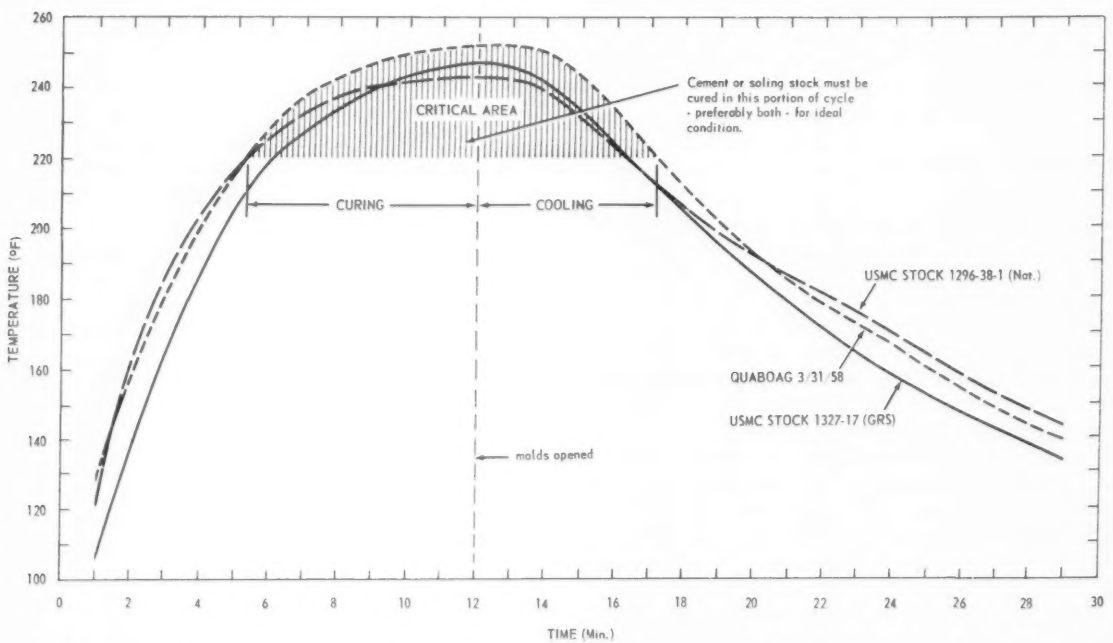

FIG. 2—Time and temperature curves for the BUVP heat transfer study for various soling stocks under varying conditions.

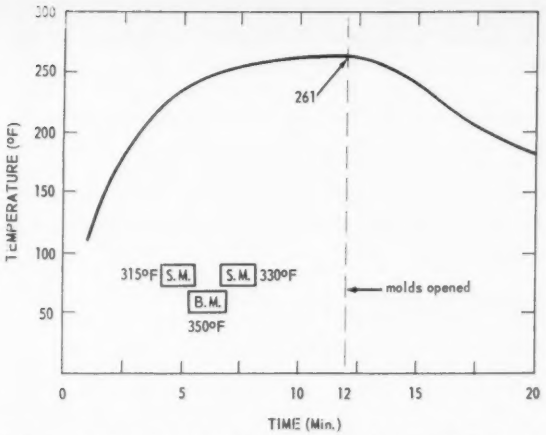

FIG. 3—Heating natural rubber soling stock to 350° F. is not recommended.

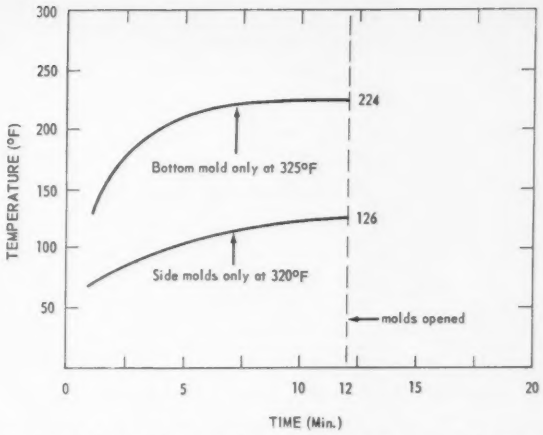

FIG. 4—Individual heating of side molds and bottom molds, using 1296-38-1 soling stock in heat transfer study.

(6) Side mold temperature plays an important role in curing the extensions of the sole. Side molds insure a tight cure at the bite line of the shoe. Close control of side mold temperature is essential to prevent leather burns. A minimum temperature is desirable.

(7) Determination of bond strength between the rubber sole and the leather upper should not be attempted until the sole has cooled to room temperature after removal from the vulcanizer. Soling stocks suitable for the molded-on process are highly accelerated and will continue to cure at reduced temperature. Our natural rubber soling stock 1296-38-1 will show a degree of cure in 3 days at 75°F. and a complete cure in the vulcanizer in six to ten minutes depending on sole thickness.

Microporous Cellular Soling Stock. Our study with

TABLE III—PHYSICAL PROPERTIES OF SOLING STOCKS FOR THE VULCANIZED-ON-SOLE PROCESS

(Developed by United Shoe Machinery Corporation)

	1296-38-1	1296-38-3	1327-17	1322-15-5	1322-25-1
Cure Rate	8 min. at 300°F.	8 min. at 300°F.	10 min. at 335°F.	12 min. at 335°F.	12 min. at 335°F.
Specific Gravity	1.30	1.30	1.19	1.22	1.23
Tensile Strength	2490	2500	2950	2745	2425
Elongation (%)	490	500	475	600	515
Hardness (A)	70–72	70	70–73	80	68
Tear (ppi)	359	350	220	286	239
Abrasion (taber)	1.247	1.25	.645	.177	.060
Abrasion (BuStd)	35.4	35.5		69	83
Flex (72°F.)	5.0×10^5	5.0×10^5	3.3×10^5	7.0×10^5	over 1.0×10^6
Flex (0°F.)	1.0×10^4	1.0×10^4	1.0×10^4	over 1.0×10^6	over 1.0×10^6
Moldability	Good at 250 psi	Good at 250 psi	Good at 250 psi	Good at 250 psi	Good at 250 psi
Storage Stability (72°F.)	3 days	over 14 days	over 20 days	30 days	30 days
Storage Stability (0°F.)	indef. 100+	indef. 100+	indef. 100+	indef. 100+	indef. 100+
Adhesion (SATRA)	Excellent	Excellent	Good	Excellent	Excellent
Heat Conductivity	100%	80%	100%	85%	85%
Sole Appearance	Good No bloom	Good No bloom	Good No bloom	Good No bloom	Good No bloom
Processibility	Good	Good	Excellent	Excellent	Excellent
Rubber Content (%)	41.0	41.5	42.6	46.5	42.5

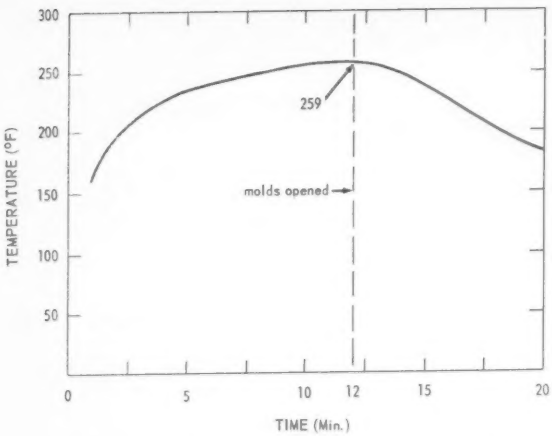

FIG. 5—Degree of heat transfer in neoprene soling stock.

this type of soling stock was very limited and was confined to several small sized shoes. Natural rubber sponge stock was used and we found that uni-directional heat was inadequate to effect a tight cure. As soon as the blow occurs, an insulation medium is formed by gas cells and the thermal conductivity drops below the range required to cure the rubber. Heating the foot form appears essential to successful molding of micro-cellular soles.

Various Investigations

Mold Lubricants and Cleaning. The molds used in our study were not chromium plated. Chrome plating or Teflon coating aids in keeping molds free of hard, insoluble surface crusts inherent with molding of rubber stocks. The Teflon coated molds used had a tendency to chip and wear and were not as effective as chromed plate molds.

We investigated a number of mold lubricants and found that silicone oil sprays (100 per cent or emulsions) were highly effective. An aerosol type silicone spray applies a very fine mist thereby preventing imperfections in molding due to excess lubricant. A number of aerosol lubricants were tried and the least expensive proved to be General Purpose Mold Release, manufactured by North Shore Laboratories, Salem, Mass.

Irregular shaped mold surfaces, such as cleats, have a greater tendency to become dirty than do smooth surfaced molds. Heavily encrusted molds can be cleaned quite readily by the use of silicone emulsion/sand blast.

Reduced Vulcanizing Time (Preheating). Prior to installation of a British United Vulcanizing Press unit, the plant manager said that he would live with the 12 minute cure for a while but eventually would expect a much shorter cure time. Obviously, a shorter cure time would increase production and would be reflected in a more profitable operation for the shoe manufacturer.

Emphasis on a shorter cure time poses a problem to the rubber manufacturer. Highly accelerated soling stocks introduces such problems as processing and storage stability. The research efforts of the USMC team defined the limitations of accelerated cures by chemical means. In an effort to support BUVP installations, coupled with satisfying the needs of the shoe and rubber manufacturers, the USMC team resorted to physical means in the form of pre-heat assists.

Suitable Preheat Method

The objective of this study was to determine the most suitable preheat method that would insure: (1) Minimum vulcanizing time. (2) Rubber processing safety. (3) Adequate shelf life.

Once again the study was restricted to uni-directional heating with no assist from heated, metallic foot forms as used in string lasted techniques. Our studies of the several preheat methods included: (1) Dielectric heating (high frequency RF). (2) Radiant heating, single and dual surface exposure. (3) Conductance heating. (4) Circulating hot air.

Electronic Heating

Several authors have explained the details of electronic heating *(6)*. Materials conducive to dielectric heating must be polar, containing oppositely charged atom pairs called "dipoles." Dipoles placed in an electric field will attempt to align with the potential gradient, setting up a torque called "dipole moment." By high frequency reversal of the electrical field, the dipoles attempt to align with each directional change. The medium containing the dipoles resists realignment absorbing energy in the form of heat commonly known as "dielectric loss." Materials with

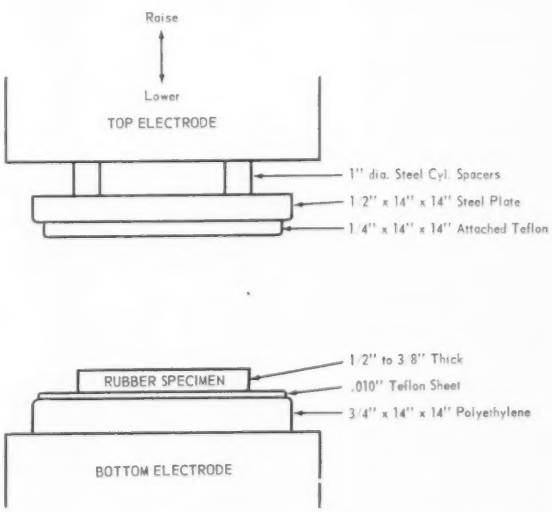

FIG. 6—Rubber specimens from 1/2 to 3/8 inch were tested in this heater.

a high loss factor are readily heated electronically. An extensive tabulation of high loss materials was compiled by A. Von Hippel *(7)*. We used equipment with the following specifications:

Thermal RF heater, model 1000 (LaRose).
Power output: 15 kv.
Heating capacity: 10 lbs. compound a minute, (240°F. to 250°F.).
Electrode area: 16 inches by 18 inches.
Electrode spacing: 1.5 inch to 6.25 inch.
Frequency: 48 to 60 mc.
Power line current: 230 v, 70 amp.

The heater was converted to low voltage operation. This was more than adequate for this study. Some modification was required to offset the minimum spacing between electrodes in order to accommodate rubber specimen ½ inch to ⅜ inch thick. This was accomplished as shown in Figure 6.

Purpose of Teflon

The Teflon which sandwiches the specimen serves the dual purpose of proper spacing and ready release of tacky rubber compositions. Polyethylene and Teflon are recommended due to low loss factors *(7)*.

LaRose Manufacturing Company recommends a ¼ inch air space above the specimen for most efficient heating. We found it necessary to slightly compress the rubber specimen between the contact surfaces in order to level specimen surface irregularities that result in "hot spots" or arcing.

TABLE IV—PREHEATING VARIOUS GUMS

Specimen thickness: ½ inch

	Ambient Temp. (°F.)	Electrode Distance (inches)	Time Cycle (sec.)	Center Heat (°F.)
NBR (Chemigum N6B)	80	2¾	4	225
NBR (Chemigum 1052)	80	2¾	4	230
NBR (Chemigum N-8)	80	2¾	4	230
NBR (Chemigum N-6)	80	2¾	4	230
NBR (Hycar 1001)	80	2¾	4	230
NBR (Hycar 1072)	80	2¾	4	230
NBR (Hycar 1042)	70	2¾	4	200
Polyacrylic (Hycar 4021)	70	2¾	4	150
SBR (Plioflex 1502)	80	2¾	4	80
SBR (Plioflex 1502)	80	2¾	60	160
SBR (Plioflex 1773)	80	2¾	4	80
Neoprene (WRT)	80	2¾	4	165
Neoprene (GN)	80	2¾	4	170
Butyl (365)	80	2¾	4	80
Chlorinated Butyl (Enjay MD 551)	80	2¾	4	140
Polyurethane (Genthane S)	80	2¾	4	140
Polyurethane (Adiprene B)	80	2¾	4	Broke Needle
Nat. Reclaim	80	2¾	4	90
Pale Crepe	80	2¾	4	80
			60	130
Smoked Sheet	80	2¾	4	90
			30	110

TABLE V—CURING SYSTEMS

Curing System	Standard Nitrile Stock (Control)	(2)	(3)	(4)
Sulfur	2.0	2.0	2.0	2.0
Thiazyl acc.		1.5	1.5	1.5
Thiazole acc.			1.0	
Dithiocarbamate MeZimate	1.5			
Cumate	0.2			
Amine				0.75
Maximum preheat tolerance	200°F.	310°F.	250°F.	270°F.

Preheating Gum Rubbers. The degree of heat induced by RF heating was studied for natural and several synthetic gums. The need for uniformly thick specimen was apparent and this was accomplished as follows: (1) Rubber breakdown by 10 minute milling. (2) Freezing in dry ice/acetone bath. (3) Band sawing to desired thickness. (4) Thawing to ambient temperature.

Heat determinations were made at the center of the heated specimen using a needle, surface pyrometer. Results are shown in Table IV.

Priority for NBR Type Gum

Since NBR type gum was most receptive to RF heating, it commanded priority in the shoe bottoming study. Utilizing previous United Shoe research on NBR type soling material, we directed our study toward determination of maximum induced heat to minimize vulcanizing time without danger to scorching or precure. With United Shoe Machinery Corporation nitrile soling stock 1322-15-7, RF heating revealed the following:

(1) Degree of heat induced varies directly with electrode spacing.

(2) This stock, accelerated by a dithiocarbamate system, can be preheated to 200°F. without scorching. Above this temperature, volatile matter present creates a cellular structure that is tightly cured at 250°F.

(3) When preheated to 200°F. the subsequent vulcanizing time for the soling stock is six minutes.

(4) Plasticity is increased four times. Mold flow, determined by spew, indicates a half-minute for preheated stock compared with two minutes for stock that has not been preheated.

(5) The 200°F. through heat is reached in four to eight seconds, depending on electrode spacing.

(6) The preheated stocks, vulcanized in half the normal curing cycle, showed neither inferior physical properties nor inferior bonds to leather..

(7) Heat loss from preheated stock when removed from the RF heater varies with stock thickness and the degree of induced heat.

(8) Preheated sole is limp but can be handled.

TABLE VI—RADIANT HEATING

Time (min.)	Temperature of Surface Near Heat (°F.)	Temperature at Center (°F.)	Temperature of Opposite Surface (°F.)
1	150	70	70
3	210	110	80
5	230	145	95
10	280 cured ⅛ inch depth	210–220	130

Safe Processing Stock. Slower curing systems are more adaptable to the RF preheat method. A number of curing systems were studied to determine the maximum tolerable induced heat that would prevent scorching. A few of these stock systems are shown in Table II.

The use of system three in Table V resulted in the following: (1) Increased scorch time by 400 per cent (3 minutes to 12.5 minutes). (2) Storage stability of one month at 90°F. continuous heat. (3) A satisfactory cure in six minutes after 240°F. to 250°F. preheat. (4) Physical properties were comparable to control (standard 12 minute cure).

Work shoes were made in accordance with above outlined system and subjected to vigorous field trials. No evidence of rubber failure was observed after one year of continuous wear under the very rugged conditions obtaining in an oil refinery.

Heating Aids. Certain fillers enhance dielectric heating of rubber stocks *(6)*. The best of fillers for this purpose is carbon black which is prohibitive in a non-marking soling stock. A few materials that showed promise in our study included:

(1) Sulfonamides
(2) Phenol-formaldehyde resins
(3) Urea-formaldehyde resins
(4) Cellulose derivatives
(5) Polyvinyl pyridine
(6) Polyvinyl chloride resins
(7) Natural resins

Air Circulating Oven. Very little effort was expended in this study when it was determined that this preheating method was very slow. The NBR soling stock used in the RF study was placed in an air circulating oven set at 200°F. The time element to reach 200°F. at the center of the biscuit was approximately 30 minutes. There was no evidence of scorch in the specimen.

We learned that one of the fast curing USMC natural rubber soling stocks when preheated to 150°F. in the oven required only 4½ minutes in the BUVP for a complete cure.

Radiant Heating: A radiant heat source was used in the study of single exposure radiant heating. Heel and sole biscuits were measured for heat absorbed. The results are shown above in Table VI, "Radiant Heating."

The uneven heat distribution by the radiant method sharply contrasts with the uniform heat of the RF method. It should be noted, however, that the radiant method reaches 210°F. on the closest surface in three minutes, contributes considerably to cure of the adhesive, and reduces over-all cure time. This method was tested in the field and improved the degree of cure in very thick heel sections. The major deficiency of this type of preheating is the lack of control to prevent scorching of relatively fast curing stocks.

Compare RF and Radiant Methods

Figure 7 shows soling stocks preheated by radiant method compared to the RF method. Heat measurements were taken at the rubber/leather interface during vulcanizing by the previously described method. Although both test specimens were preheated to 200°F. the differential in surface heat loss, during transfer to vulcanizer, is greater in the radiant heated sample. This accounts for the initial lag and the parallel nature of the curves.

In the method of dual surface exposure, we utilized

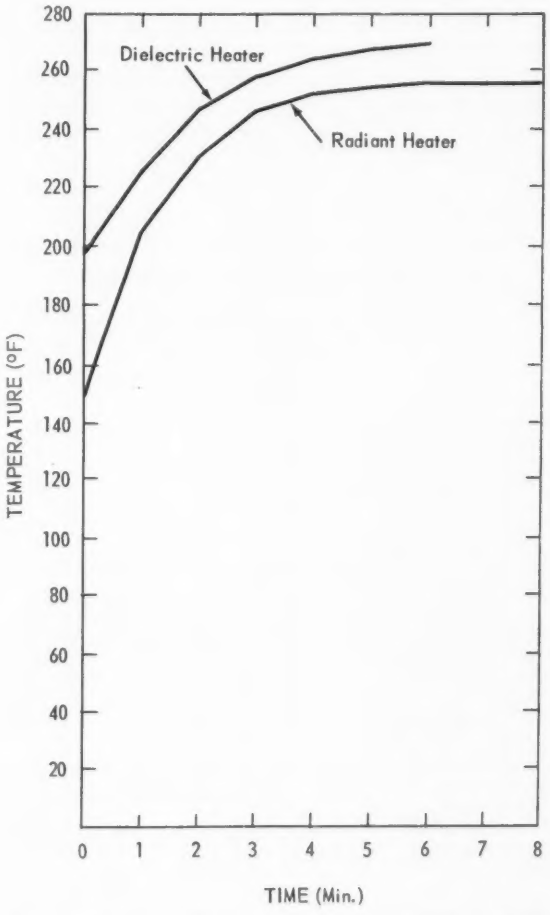

FIG. 7—Heat measurements were taken at the leather/rubber interface for radiant and dielectric preheat methods.

a dual radiant heater in the form of a king-size pop-up toaster. Heat input was controlled by a 15 ampere powerstat. The degree of preheat was determined by affixed thermocouples, as shown in Figure 8. The difference in heat between the two exposed surfaces is believed due to distance from the heating elements. This method of preheating is much more effective than the RHA heater.

Conductance Heating. This method of preheating is currently popular in Europe. A preheating unit of this type is available commercially from British United.

Figure 9 shows various thickness of soling stock 1322-15-7 (fast cure), preheated in a flat bed press with platens at 200°F. The curves depict time to reach tolerable preheat for various thickness of soling stock. It will be noted that a half inch thick soling stock requires approximately six minutes to reach the desired degree of preheat. This is comparable to the time required to complete vulcanization and could be performed concurrently during vulcanization, thus synchronizing the overall process.

A modified radiant heater or a conductance heater appears to be the most practical approach to satisfying the needs of both the shoemaker and the rubber formulators.

Dielectric Preheat Is Efficient

Of the several methods investigated, dielectric preheating appears to be the most efficient in speed, heat control, range of soling stocks, and from the standpoint of automation. The basic disadvantage with dielectric heating appears to be cost of equipment, operational cost, and operating hazards.

In general, selectivity of bottoming materials, aided by preheat assists, indicates that a four to five minute curing cycle, which allows for safety in rubber processing and adequate shelf life, is feasible. Some soling stocks can be cured with reduced side mold temperature. This eliminates heat damage to the upper leather.

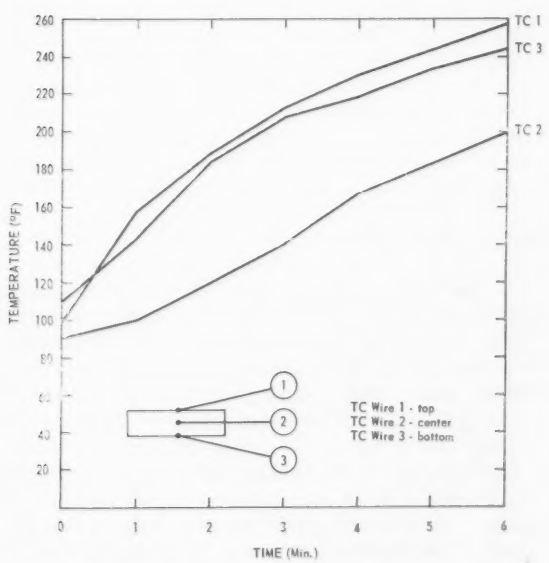

FIG. 8—Degree of preheat in the dual surface radiant heater is determined by thermocouples.

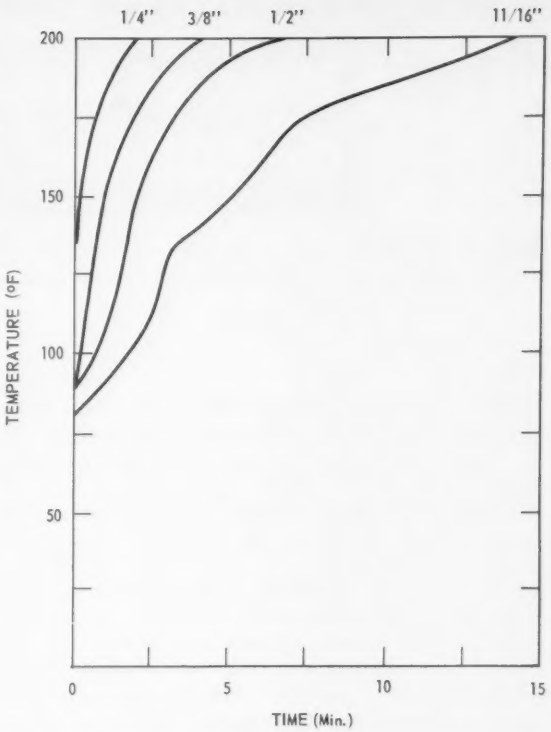

FIG. 9—Specimens of soling stock 1322-15-7 were preheated by conductance.

It is our conclusion that preheating of soling stocks appears feasible and practical for the molded-on process. Preheating of soling stocks acts as an assist in reduced vulcanizing time and makes storage stability and stock processing less critical.

Acknowledgement

The writer is grateful for the assistance of James Leahy for program guidance, William Tabroff and Roger Pollock in rubber compounding, Myron Perkins, shoe constructions and leather problems, Walter Kovaleski for assistance in mechanical problems and machine functions, Meith Maeser for physical test methods and test equipment, and Robert Bradley for assistance in dielectric studies. We wish to thank all raw material suppliers for the generous samples submitted for evaluation.

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ATTRITED CARBON BLACKS and THEIR BEHAVIOR in ELASTOMERS

PART 3 Effect of Attrited Blacks On SBR and Other Rubbers

By A. M. GESSLER
Chemicals Research Div., Esso Research & Engineering Co., Linden, N.J.

THE modification of carbon blacks by severe attrition through ball or two roll (rubber) milling was described in the first paper *(1)* of this series. Unexpectedly large increases in the surface area of the blacks were shown to attend the attrition. These increases were attributed partly to the breakage of secondary aggregate structure, and partly to abrasion or fragmentation occurring at the surfaces of individual particles. Oxidation of the blacks, the extent of which was shown to increase linearly with the surface area of the blacks, was envisioned as arising from free radical activity, unpaired electrons being made available from the homolytic cleavage of carbon to carbon bonds in the course of the attrition. The acidity of the blacks, as indicated by pH, was shown to increase with the oxidation. Oil absorption measurements finally were used to indicate the dissipation of secondary or aggregate structure in attrited carbons.

Effects on Butyl Properties

A second paper in this series *(2)* showed the effects of attrited blacks on the properties of butyl. Improved stress-strain and dynamic properties, it was proposed, resulted from an increased reinforcing capacity associated with both the physical and chemical changes rendered in the blacks by attrition. The intrinsic conflict in butyl cures between abrasion resistance on the one hand and hysteresis on the other was shown to be resolved, good abrasion resistance as well as good dynamic properties being provided with attrited blacks in samples cured for relatively short times. The advantages of attrited blacks were further reported to be maintained over a wide range of black concentrations. As a result, the use of higher loading levels was suggested for these blacks as a means of gaining economic advantages over the corresponding standard blacks. Finally, the sharp response of butyl-attrited black systems to unpromoted heat treatment *(3, 4)* was cited as further evidence for increased chemical activity in the attrited blacks.

The present paper considers the effects of attrited blacks in SBR and other elastomers with much higher unsaturation than butyl. With natural, acrylonitrile-butadiene, and chloroprene rubbers, for which illustrative data are presented, the approach involves straightforward consideration of the blacks. However, with SBR the anticipated effects of attrited blacks are not directly achieved. Cure with these blacks is severely retarded. Therefore considerable discussion is devoted first to the vulcanization behavior of SBR-attrited black systems, and second and more especially, to the unusual cure activating influence obtained when glycerol or other polyols are added in these mixtures.

Good dispersion of carbon black in elastomers is a requisite to obtaining optimum vulcanizate quality. This is especially true with attrited blacks. Since these blacks are fluffy (not pelleted or otherwise densed), and since they also have low secondary structure and high surface area, they require particular handling care. For the work reported here and in previous papers compounds were prepared on an open mill. The black was added slowly and as uniformly as possible along the length of the mill nip. In addition, the batch was cut from time to time as the black was being added, but never before the disappearance of all free black. As a general rule, we attempted to keep the amount of black falling through the mill into the pan at an absolute minimum, and particularly, to avoid the formation of compacted plates in this by-passed black. Therefore, we employed longer mixing times than normal with standard blacks. This fact, though it may constitute cause for practical concern, was not a deterrent in our work. Our first objective was to assay the intrinsic potentialities of attrited blacks, and not the prospects for their immediate adaptability to accepted commercial processes.

Retard Cure of SBR

Unless otherwise stated, the studies in this paper are restricted to the compound formulations shown in Table I. The words "attrited" and "ball milled," as in previous papers, are used interchangeably to refer to blacks which were ball milled in steel assay jars (1¼ gallon capacity) under standard conditions as already described *(1)*.

In the absence of the selected additives which will be discussed in a later section, a primary and yet surprising effect of attrited blacks in SBR is to retard cure. Table II shows a typical set of results for SBR vulcanizates with a series of ball milled HAF blacks. Cure retardation effects are seen to increase with the

time of carbon black attrition. Modulus and shore hardness are sharply decreased; extensibility is greatly increased. In addition, undesirable softening of the vulcanizate due to insufficient cure is apparent in the decay of dynamic properties. Reductions in dynamic modulus, K, are disproportionately larger than the reductions in internal viscosity, η, with the result that relative damping is increased, according to the equation:

Per cent Relative Damping $= 200/[1 + (2K/\pi^2 \eta f)]$, where f refers to frequency in cycles/second *(5)*.

Cure retardation with attrited blacks in SBR is further demonstrated by comparing similar butyl and SBR systems. This is done in Figure 1, using the same series of blacks as in Table II. Modulus in the case of SBR is decreased more than 65 per cent with HAF black, ball milled just long enough (4 hours) to increase its surface area from 80, its original value, to 90 M^2/g. This is a nominal change, considering the full extent of the surface area changes attending attrition, plotted along the abscissa.

By contrast, modulus with butyl is decreased less than 15 per cent with the same ball milled black. In this case the decrease is attributed to reduced aggregate structure in the black, rather than to cure rate differences. Finally, it is interesting to note that the curves for butyl and SBR, in Figure 1, are very nearly parallel as the surface area of the attrited black is increased from 95 to 136 M^2/g. The effects of attrition apparently yield similar changes in the modulus of both rubbers in this range of the attrition spectrum.

Cure retardation with attrited blacks in SBR is a general and consistent phenomenon. Figure 2 shows that effects similar to those just reported for ball milled HAF black are also obtained with ball milled SRF, FEF, and SAF blacks. It is noteworthy that the break in these curves, following the initial and sharp decay of modulus, is not uniquely associated with the surface area of the black.

Effect of Carbon Black Acidity

The pH of carbon black decreases very rapidly during the early stages of severe attrition. With high structure furnace blacks such as FEF, HAF, ISAF, or SAF, more than 75 per cent of the total pH change is achieved in the first four to eight hours of ball milling *(1)*. This pH change, furthermore, can be correlated with the modulus change in the resulting vulcanizate. Figure 3 shows a relationship using the butyl and SBR systems referred to in Figure 1, expressing pH reciprocally as the hydrogen ion concentration in moles/liter. Clearly, the SBR cure system is much more sensitive to carbon black acidity than is the butyl cure system. This sensitivity, though it is not understood, apparently accounts for the unique behavior of SBR with attrited blacks. Natural, acrylonitrile-butadiene, and chloroprene rubbers, like butyl, exhibit no similar cure retardation effects.

Until the time that work was initiated with SBR, reduced modulus in vulcanizates with attrited blacks was associated almost entirely with reduced aggregate or secondary structure in the black. Justification for this association was found in the fact that modulus is known to decrease when secondary structure is reduced *without* changing the pH or other properties of the black. Since the dissipation of black structure, as it is measured by oil absorption tests, and the regression of pH follow parallel courses during the attrition, it is impossible at this time to separate the influence of each on modulus. Experimental evidence *(6)* indicates, however, that modulus losses resulting from reduced black structure alone are very nearly constant (300 to 500 psi) regardless of the polymer.

Therefore, critical cure differences between SBR and butyl seem to be a reflection of differences in

TABLE I—BASE FORMULATIONS

STYRENE RUBBER
Compounds cured at 300°F.

GR-S 1500	100.0
Phenyl-β-Naphthylamine	0.5
Black	50.0
Stearic Acid	1.0
Zinc Oxide	5.0
Sulfur	2.0
2,2′Benzothiazyl disulfide[1]	1.5
Zinc Diethyl-Dithiocarbamate[2]	0.15

NATURAL RUBBER
Compounds cured at 287°F.

Smoked Sheets	100.0
Phenyl-β-Naphthylamine	0.5
Black	50.0
Stearic Acid	3.0
Zinc Oxide	5.0
Sulfur	3.0
Mercaptobenzothiazole[3]	1.0

ACRYLONITRILE RUBBER
Compounds cured at 287°F.

Hycar OR 15	100.00
Black	50.0
Stearic Acid	1.0
Zinc Oxide	5.0
Sulfur	1.5
2,2′Benzothiazyl disulfide[1]	1.0
Diphenylguanidine[4]	0.25
Dibutyl Phthalate	5.0

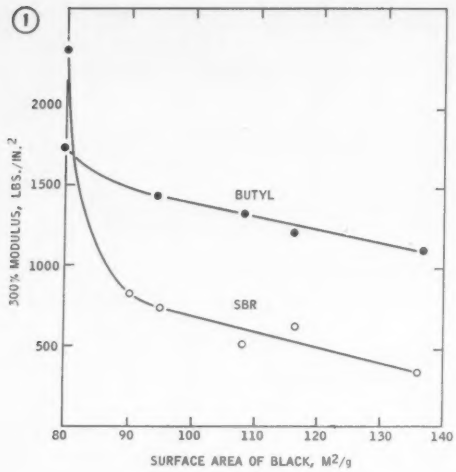
CHLOROPRENE RUBBER
Compounds cured at 287°F.

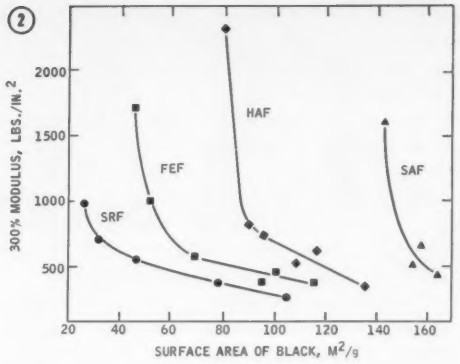
Neoprene GN	100.0
Black	50.0
Magnesia	4.0
Neozone A	2.0
Zinc Oxide	5.0
Sulfur	1.0
Diphenylguanidine	1.0

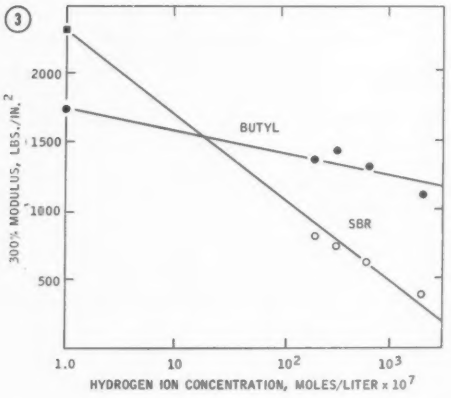
BUTYL RUBBER
Compounds cured at 307°F.

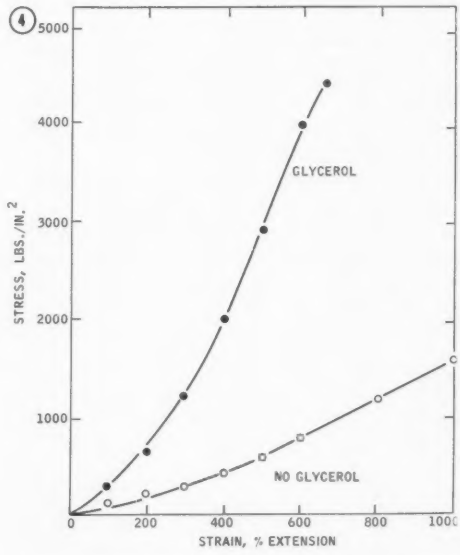
Enjay Butyl 217	100.0
Black	50.0
Stearic Acid	0.5
Zinc Oxide	5.0
Sulfur	2.0
Tetramethylthiuram disulfide[5]	1.0
2,2′Benzothiazyl disulfide[1]	1.0

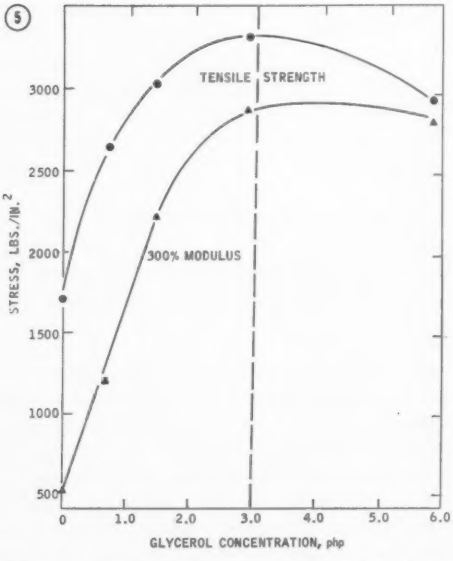
(1) Altax, (2) Zimate, (3) Captax, (4) D.P.G., (5) Tuads.











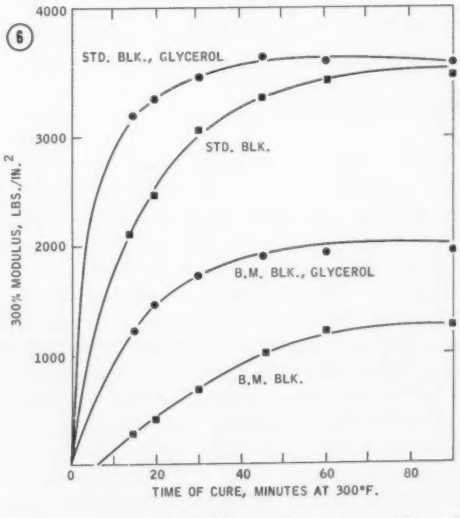


FIG. 1—Effect of surface area of attrited HAF black on modulus of butyl and SBR, cured 45 minutes at 300°F.; FIG. 2—Effect of surface area of attrited blacks on modulus of SBR, cured 45 minutes at 300°F.; FIG. 3—Vulcanizate modulus relation to hydrogen ion concentration of black compared for butyl and SBR, cured 45 minutes at 300°F.; FIG. 4—Stress-strain curves compare SBR-attrited black vulcanizates, with and without glycerol, cured 15 minutes at 300°F.; FIG. 5—Modulus and tensile strength show effect of glycerol concentration in SBR with attrited FT black, cured 30 minutes at 300°F.; FIG. 6—Modulus curves show effect of glycerol on cure of SBR with standard and ball milled HAF blacks.

the sensitivity to acidity in the black, as is indicated in Figure 3. With this in mind, limitation of the oxidation, and hence the acidity, of severely attrited blacks is suggested as an approach to "tailoring" these blacks for SBR. If oxidation is the result of free radical activity, as we have proposed *(1)*, the use of free radical acceptors in the attrition reaction might constitute a means for accomplishing this purpose.

Some General Glycerol Effects

The cure of SBR with attrited blacks is greatly improved when polyols, like glycerol, are added in the compound. This effect, which is discussed in detail in the next several sections of this paper, is preceded here with a short discussion of the literature pertaining to the use of glycerol in rubber and other elastomers.

The use of glycerol in rubber has recently been reviewed *(7)*. Glycerol and other polyols are employed as auxiliary agents in the development of optimum mechanical properties. Chemisorption at the surface of active fillers and direct chemical reactions involving the vulcanization system are proposed as mechanisms for this effect. Howland and coworkers *(8)* studied aqueous phase diluents in the emulsion polymerization of butadiene-styrene rubber, and found that polymer synthesized in the presence of glycerol exhibited abnormally high stiffening in tread type compounds, and cured considerably more rapidly than standard styrene rubber. They offered no explanation for this result, but reported that similar effects were not obtained when methyl alcohol was used in place of glycerol. The increased vulcanization rate and higher modulus and tensile strength in styrene rubber-hydrated silica systems containing ethylene glycol were also demonstrated *(9)*.

Addition of Glycols

Hausch *(10)* found that the addition of glycols or amines to silica decreased the adsorption of malachite green on the pigment. He proposed that glycols and amines reduced the accelerator adsorption in mixtures of Hevea and silica, and that this led to improved vulcanizates. Previous work in these laboratories *(11)* showed that glycerol in conventional butyl-silica systems yielded little improvement in vulcanizate quality. In butyl-silica systems which were heat treated, however, glycerol produced vulcanizates with improved modulus, tensile strength, and dynamic properties. Polyol activation of thermal interaction between the filler and polymer was envisioned. Finally, Tinyakova and coworkers in Russia have proposed that hydrogen sulfide formed by the reduction of sulfur with polyols is an explanation for cure acceleration effects which are obtained with these agents *(12)*. Data from solution studies were offered to support this proposition.

The greatly enhanced properties which result in SBR-attrited black vulcanizates when glycerol is present have already been mentioned. Curves in Figure 4 show this effect, and demonstrate the improved stress-strain properties which result from the use of glycerol (3.0 php) in an SBR compound with ball milled HAF black. The ball milled black used in this work, and in all subsequent work in this paper dealing with HAF black, was characterized by the following analytical data: surface area = 106 $M^2/g.$, weight % oxygen = 1.57, slurry pH = 4.0, oil absorption = 0.61 cc./g. Typical properties for a standard HAF black are listed in Table II. The oil absorption value for the standard black is 1.08 cc./g.

TABLE II—EFFECT OF ATTRITED HAF BLACKS ON PROPERTIES OF SBR

Compounds cured 45 minutes at 300°F.

Time of ball milling, hours	0	4	8	12	24
Surface area of black, $M^2/g.$	80.0	90.0	95.0	108.0	136.0
Oxygen content of black, Wt. per cent	0.58	0.81	1.04	1.18	1.72
pH of black	6.9	4.5	4.3	4.1	3.5
Properties of SBR vulcanizate					
Modulus at lb/in^2					
100%	415	200	190	165	150
300%	2325	825	750	545	355
500%		2000	1865	1410	855
700%		3430	3215	2505	1850
Tensile strength, $lbs./in.^2$	3495	3460	3430	3220	1925
Per cent elongation	425	705	740	800	815
Dynamic properties					
$\eta f \times 10^{-6}$, poises x cps	4.28	3.67	3.87	3.49	3.01
$K \times 10^{-7}$, dynes/cm^2	11.3	8.19	8.43	7.66	6.38
per cent relative damping	26.3	30.4	31.0	30.9	31.8
Shore hardness	53	46	43	42	35

The effect of glycerol concentration was studied in SBR compounds containing 40 volumes (72.0 php) of ball milled FT black (surface area = 128 $M^2/g.$, weight % oxygen = 1.97, slurry pH = 4.35). Since this work involved other considerations, which are outside the scope of this paper, the base formulation in Table I was changed to contain increased quantities of sulfur and accelerators: 2.75 parts sulfur, 1.75 parts 2,2'benzothiazyldisulfide, 0.2 parts zinc diethyldithiocarbamate. Modulus and tensile curves in Figure 5 show the results which were obtained. In accordance with these data, glycerol concentration at 3.0 php was taken as the standard for the work reported in this paper. No attempt was made to investigate the interrelation between the optimum glycerol requirement and the concentration and type of black. It is nevertheless recognized that systematic study of these parameters might be of great value in understanding more clearly the role played by glycerol in SBR-attrited black systems.

Glycerol Effect is Unique

The powerful cure activating effect of glycerol is unique in SBR systems with attrited blacks. Glycerol increases the rate of cure in systems with standard black, but it has little or no effect on the ultimate state of cure. The upper curves in Figure 6 show that modulus increases at early cure times when glycerol is present in this kind of compound. However,

the difference virtually disappears when the cure time is extended to 60 minutes or longer. Modulus values then tend to be the same, regardless of the presence of glycerol. By contrast, SBR-attrited black compounds containing glycerol (lower curves in Figure 6) display not only increased cure rate, indicated by the steeper slope in the early portions of the glycerol curve, but the ultimate modulus after both curves have leveled is 58 per cent higher in this case. Both cure rate and cure state effects are attributed to glycerol in these systems.

The equilibrium swelling capacities of the vulcanizates used in the work of Figure 6 were measured in toluene (48 hours at 25 ± 0.5°C.). The results in Figure 7 corroborate the conclusions drawn from the modulus data in Figure 6. Volume swell values, particularly for samples at long cure times, tend to be the same for standard black compounds with and without glycerol. With attrited black, however, the presence of glycerol leads to vulcanizates with higher cross link density and significantly lower swelling capacity. The reversal in the swell curve shown in Figure 7 for the ball milled black vulcanizate without glycerol is not paralleled by the corresponding modulus curve in Figure 6. No explanation for the divergence is offered. Reversion, in the sense of softening, is generally not experienced with styrene-butadiene rubbers, which tend to harden or resinify on extended curing or on heat aging. The slight increases in volume swell, occurring when the vulcanizates with standard black and glycerol are cured for longer times, is also unexpected. However, since the samples were weighed originally but not finally after drying, the influence of extractable matter may be a factor in these results.

Requires SBR

The unique nature of the glycerol cure activation effect in SBR-attrited black systems is further demonstrated when the results in Figure 6 are compared with those obtained from similar experiments with butyl or natural rubber. Figure 8 shows that in butyl compounds containing standard black, the modulus of the glycerol systems is uniformly lower. This suggests a simple diluent or plasticizer action as the role of glycerol in these vulcanizates. The loss of modulus which glycerol produces in butyl compounds containing ball milled black, however, is larger than would be expected from diluent action alone, and increases with the time of cure. Thus, the glycerol effect in butyl is not only very much smaller than that in SBR but, oddly enough, in the opposite direction. In the presence of glycerol, modulus is depressed in butyl, and enhanced in SBR. This is especially true in systems with attrited blacks.

Detailed tensile and cure data from these experiments with SBR and butyl are presented in Tables III and IV, respectively. Careful inspection of the values in the first four columns of each of these tables will convince the reader that SBR and butyl are indeed different in their response to the separate influences of attrited black and glycerol. The remarkable and striking results in Table III have been referred to already, but in much less detail. It is noteworthy in Table IV that tensile strength and extensibility suffer very little change as a result of glycerol addition when butyl is compounded with standard black. This seems to support the proposition which was suggested by the modulus data, namely, that the glycerol effect is simply a plasticizer or diluent effect. Much greater changes in tensile strength and elongation are observed when glycerol is added in the butyl compound with attrited black. These results, like the modulus data, imply that important changes in either the cure or reinforcement systems, or both, attend the use of glycerol in this case.

The uniqueness of the glycerol cure activation effect in SBR systems containing attrited blacks is associated with both the polymer and the black, as already described. Additional support for this statement is found in the fact that similar results are not obtained with natural or butadiene-acrylonitrile rubbers. Attrited blacks do not lead to cure rate difficulties in these elastomers, and the addition of glycerol produces insignificant changes in the quality of the vulcanizates, regardless of the nature of the black.

Independent of Sulfur

In attributing the uniqueness of the glycerol effect in SBR to the polymer and the black, the possibility had to be considered that the activity of glycerol might instead be related to the particular chemical environment of the cure, i.e., to the chemical activity of the accelerator or accelerator combination used to make the cure. SBR vulcanizates containing ball milled black were therefore prepared with the accelerator systems which were used in butyl and natural rubber, and which gave neither cure retardation nor glycerol activation effects in these polymers. Table V shows that in the absence of glycerol, attrited black retards the cure of SBR to very nearly the same extent for the three accelerator systems studied. Similarly, the magnitude of the glycerol activation effect appears to be about the same in the three cases shown. From this, the dependence of these phenomena on the polymer composition and the black type seems assured.

It is interesting to note in Table VI that SBR, when cured with dicumyl peroxide (Di Cup at 1.0 php) without sulfur or accelerators, suffers little or no cure retardation with attrited blacks. This observation is contrary to expectation since acidic compounds are generally not recommended for use in peroxide cured vulcanizates *(13)*. Glycerol yields relatively small cure activation effects in peroxide cured SBR. Though glycerol has a greater activity in the attrited black compound (Table VI), the vulcanizate changes it produces are small, when compared with the changes in the corresponding sulfur cured compound.

In further consideration of the glycerol effect, SBR-attrited HAF black systems were studied with other hydroxy compounds substituted for glycerol. The standard formulation was used in this work, and the concentration of the substituted polyols was taken as

TABLE III—CURE STUDY SHOWING EFFECT OF GLYCEROL IN SBR WITH STANDARD AND ATTRITED HAF BLACKS

Condition of black	Not Heat Treated				Heat Treated			
	Ball Milled		Standard		Ball Milled		Standard	
Glycerol, php	——	3.0	——	3.0	——	3.0	——	3.0
Cured 15 min. at 300°F.								
Modulus at lb/in²								
100%	135	325	430	690	200	200	410	600
300%	305	1235	2090	3205	575	625	2410	3360
500%	610	2910			1815	1960		
800%	1220							
Tensile strength, lbs./in.²	1610	4445	3650	3670	3135	3735	3735	3800
Per cent elongation	1000+	655	490	360	735	740	460	355
Shore hardness	49	61	63	68	47	48	62	65
Cured 20 min. at 300°F.								
Modulus at lb/in²								
100%	130	375	485	670	205	215	470	695
300%	430	1505	2475	3355	850	960	2785	3680
500%	1005	3505			2665	2825		
700%	1790							
Tensile strength, lbs./in.²	2620	4415	3910	3655	4000	4115	3860	3820
Per cent elongation	925	585	460	330	625	670	420	320
Shore hardness	51	62	64	69	47	49	61	65
Cured 30 min. at 300°F.								
Modulus at lb/in²								
100%	215	395	660	755	250	260	570	730
300%	695	1750	3065	3565	1190	1290	3170	3665
500%	1815	4090			3525	3665		
Tensile Strength, lbs./in.²	3630	4340	3790	3710	4370	4545	3985	3665
Per cent elongation	755	530	380	320	590	600	380	300
Shore hardness	53	63	66	68	50	50	64	66
Cured 45 min. at 300°F.								
Modulus at lb/in²								
100%	260	390	650	785	275	265	620	750
300%	1035	1910	3350	3755	1645	1695	3430	
500%	2655	4335				4265		
Tensile Strength, lbs./in.²	4450	4515	3935	3755	4525	4730	3765	3700
Per cent elongation	690	530	365	300	510	535	335	290
Shore hardness	56	63	68	69	53	55	66	67
Cured 60 min. at 300°F.								
Modulus at lb/in²								
100%	305	390	675	770	285	300	660	705
300%	1250	1950	3495	3695	1850	1870	3600	
500%	3115				4810	4400		
Tensile Strength, lbs./in.²	4675	4430	3775	3695	4810	4400	3725	3720
Per cent elongation	565	520	325	300	500	500	320	295
Shore hardness	60	64	68	69	54	57	67	68

a molar equivalent of glycerol at 3.0 php. Results are given in Table VII, listing the hydroxy compounds in order of increasing cure activity as judged by the 300 per cent modulus.

Other Polyols Studied

Aromatic hydroxy compounds (mono-, di- and trihydric phenols) are generally undesirable. Cure is not obtained at all with three of these, even when the vulcanization time is extended to sixty minutes. Two others give little or no improvement over the control compound which was prepared without polyol addition. Hydroquinone alone shows positive results in terms of increased modulus, increased tensile strength, and reduced extensibility. Since phenols are weak acids, and since the vulcanization of SBR is sensitive to acid (Figure 3), one might suspect that phenol responses are related to phenol acidity. This is evidently not the case, as shown by the widely different results obtained with catechol, resorcinol, and hydroquinone. All of these have roughly the same dissociation constants.

Monohydric alcohols such as n-propyl alcohol or lauryl alcohol yield little if any enhancement of cure, even when their concentrations are increased to provide the same number of hydroxyl groups as glycerol. Aliphatic polyols, however, generally appear extremely effective. Ethylene glycol and 1,2,6 hexanetriol promote cure to a greater extent than does glycerol, despite the fact that lower tensile is obtained with these polyols than with glycerol. Experiments with trimethylene glycol (propandiol-1,3) indicate that the reactivity of polyols is not necessarily associated with the 1,2 structure of the hydroxyl groups which is characteristic of glycerol, ethylene glycol, and 1,2,6

TABLE IV—CURE STUDY SHOWING EFFECT OF GLYCEROL IN BUTYL WITH STANDARD AND ATTRITED HAF BLACKS

Condition of Black	Not Heat Treated				Heat Treated			
	Ball Milled		Standard		Ball Milled		Standard	
Glycerol, php	—	3.0	—	3.0	—	3.0	—	3.0
Cured 20 min. at 307°F.								
Modulus at lb/in²								
100%	200	175	350	330	200	200	360	330
300%	740	580	1350	1220	980	700	1370	1270
500%	1900	1400	2315	2240	2510	1800	2335	2300
Tensile strength, lbs./in.²	3050	2850	2400	2430	3400	3000	2480	2470
Per cent elongation	710	775	540	570	670	720	560	565
Shore hardness	52	54	64	63	48	51	62	62
Cured 30 min. at 307°F.								
Modulus at lb/in²								
100%	225	220	450	400	230	225	440	400
300%	920	700	1625	1500	1250	950	1650	1600
500%	2250	1670			2850	2200		
Tensile strength, lbs./in.²	3000	2870	2300	2300	3235	2890	2375	2360
Per cent elongation	660	705	440	460	580	660	450	455
Shore hardness	53	53	66	65	50	55	65	65
Cured 45 min. at 307°F.								
Modulus at lb/in²								
100%	275	250	530	430	275	260	515	475
300%	1150	880	1900	1810	1475	1110	1930	1875
500%	2600	2035			3050	2370		
Tensile strength, lbs./in.²	3000	2775	2275	2200	3150	2700	2335	2260
Per cent elongation	575	660	380	370	515	585	370	380
Shore hardness	56	55	67	67	53	54	68	67
Cured 60 min. at 307°F.								
Modulus at lb/in²								
100%	270	250	550	475	290	280	550	510
300%	1315	1000	2050	1980	1600	1190	2050	1975
500%	2800	2175				2475		
Tensile strength, lbs./in.²	2900	2700	2225	2310	3000	2600	2235	2260
Per cent elongation	535	615	340	365	475	525	340	360
Shore hardness	54	55	68	64	54	55	64	67

hexanetriol.

Hausch *(9)* showed that in Hevea the adsorption of malachite green on silica was reduced by both polyols and polyamines. Since no similarity appears in the cure activating effect of diethylenetriamine and the polyols in Table VII, the activity of the latter must be attributed to something more than the placation of adsorptive tendencies on the part of the filler. Polyols are believed to be involved somehow in interactions with the polymer, the black, and the curing systems. Polyamines, at least diethylene triamine, are not similarly involved in these interactions.

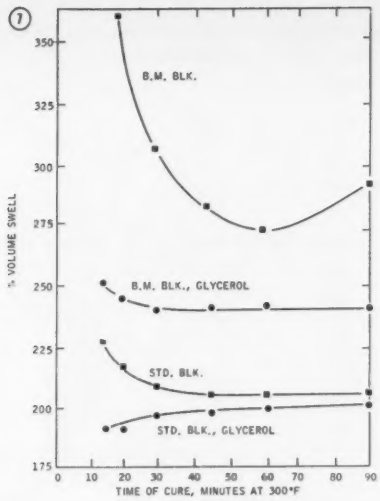
Attrited Blacks Improve SBR

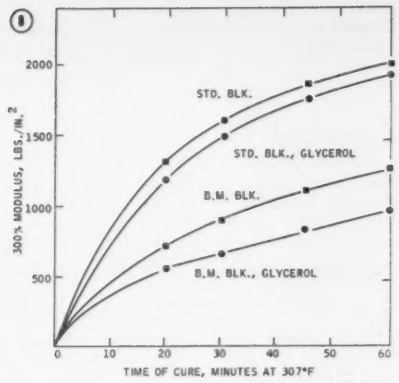
When the compounds are properly cured in the presence of glycerol or other polyols, as has been described, attrited blacks lead to SBR vulcanizates with improved properties. The nature of these improved properties is discussed in the next several sections of this paper. For this discussion, attrited black compounds were prepared with glycerol as already specified (3.0 php). Due to the increased shortness and hardness which result when glycerol is added in SBR systems with standard black (Table III), no glycerol was used in the preparation of these systems. Vulcanizates were cured for 30 minutes at 300°F.

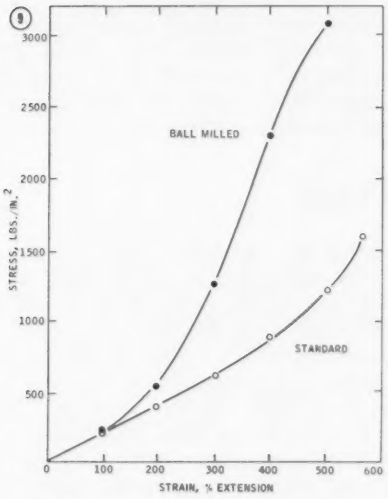
Stress-Strain Curves Shifted

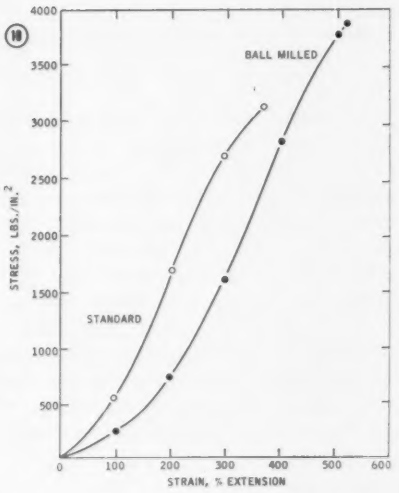
As was the case with butyl *(2)*, SBR vulcanizates containing attrited blacks are characterized by increased tensile strength and extensibility. For the coarser blacks, such as FT black (Figure 9), the stress-strain curve is shifted in the direction of increased stress. Activation of the black by ball milling in this case is believed to lead to increased numbers of polymer-carbon attachments. As a result, the reinforcing action of the black is greatly increased. FT black is a subnormal structure black. The geometry of its particle distribution, i.e., its secondary aggregate structure or oil absorption capacity, is not appreciably changed by ball milling. Similar results are obtained with MT black.

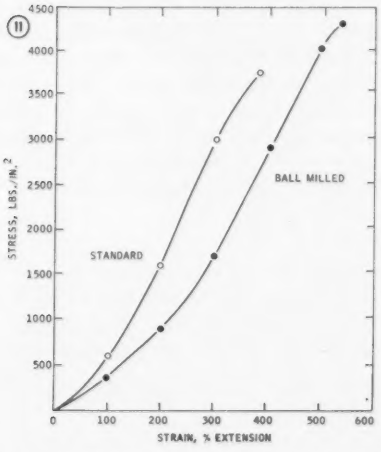
The formation of increased numbers of polymer-carbon attachments is claimed for ball milled FT black systems and for attrited black systems gen-











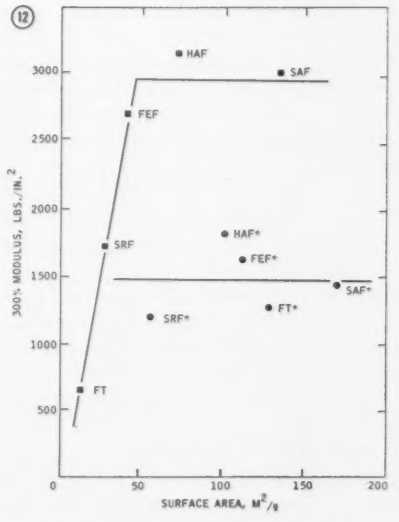


FIG. 7—Equilibrium volume swell curves show effect of glycerol on cure of SBR with standard and ball milled HAF blacks; FIG. 8—Modulus curves show effect of glycerol on cure of butyl with standard and ball milled HAF blacks; FIG. 9—Stress-strain properties of SBR are shown for vulcanizates with standard and ball milled FT blacks; FIG. 10—Stress-strain properties of SBR are shown for vulcanizates with standard and ball milled FEF blacks; FIG. 11—Stress-strain properties of SBR are shown for vulcanizates with standard and ball milled HAF blacks; FIG. 12—Effect of surface area of several blacks on the modulus of SBR is shown for vulcanizates with standard and ball milled blacks.

TABLE V—COMPARISON OF GLYCEROL EFFECT IN SBR COMPOUNDS WITH DIFFERENT ACCELERATOR SYSTEMS

Glycerol, php	——	3.0	——	3.0	——	3.0
2,2′ benzothiazyl disulfide	1.5	1.5	0	0	1.0	1.0
Zinc diethyl dithiocarbamate	0.15	0.15	0	0	0	0
Mercaptobenzothiazole	0	0	1.5	1.5	0	0
Tetramethylthiuram disulfide	0	0	0	0	1.0	1.0
Cure	15 min. at 300°F.		30 min. at 300°F.		20 min. at 260°F.	
Modulus at lbs./in.²	140	240	150	370	150	365
100%	315	1220	300	1445	310	1550
500%	705	2930	610	3470	720	3515
700%	1210		935		1240	
900%	1750				1935	
Tensile strength, lbs./in.²	1850	3685	1200	3950	2250	3600
Per cent elongation	950	590	960	565	985	515
Shore hardness	54	58	50	63	51	65

erally. The interaction of carbon black with polymer free radicals formed during milling is one possible mechanism *(14)* for bringing about these attachments. This concept was invoked in the discussion of attrited blacks in butyl *(2)*. However, the possibility for carbon-polymer interaction during vulcanization, by free radical mechanism *(15)*, or more probably, by complex oxidation-reduction schemes which also involve sulfur *(16)*, seems much more likely with SBR. The unique nature of the cure retardation, and concomitant glycerol activation effects in sulfur cured SBR-attrited black systems, seems to be entirely in accord with the requirements for this latter mechanism.

Action with Finer Blacks

With finer blacks—specifically, the high structure furnace blacks—the stress-strain curve is shifted in the direction of reduced stress. Figures 10 and 11 show results for FEF and HAF blacks, respectively. Reduced stress in these systems is attributed to the dissipation of secondary or aggregate structure in the blacks. The effect of the increased surface activity of the attrited blacks is believed to be overshadowed, in these cases, by viscosity effects. Viscosity of the elastomer-black matrix is much less in the absence of secondary or aggregate carbon structure.

Dependence of vulcanizate modulus on structure, i.e., geometric complexity, of dispersed carbon black was recognized in previous work with butyl *(2)*. A similar situation is obtained with SBR. Once the geometric complexity of the black is reduced to a nearly constant state by attrition, the vulcanizate modulus at uniform black concentration tends to seek a common level, regardless of the surface area or the surface activity (oxygen content) of the attrited black. This behavior, shown in Figure 12, is the same as shown for butyl in the previous paper. Because of greater sensitivity of cure in SBR, the points for SBR vulcanizates with attrited blacks are somewhat more scattered than for corresponding butyl systems. Similarly, greater modulus increases are observed as structure or geometric complexity of standard blacks increases from FT to SFR, up to the high structure furnace blacks, FEF, HAF, and SAF. Roughly, the latter standard blacks have the same, strong aggregation habits and give the same high values for vulcanizate modulus.

Viscosity Reduced

If viscosity and relaxation effects are indeed related to geometric complexity of carbon black, as we have suggested, this should be apparent in raw mixtures of polymer and black and should become larger as concentration of black is increased. This is confirmed by the Mooney viscosity plots in Figure 13. Lower viscosity is obtained with attrited black. The curves diverge for mixtures of SBR with standard and attrited HAF blacks. Viscosity of the standard black system, only ten Mooney points higher at twenty volumes loading, is eighty points higher at sixty volumes loading. This clearly demonstrates the decreased viscosity which results in an elastomer compound when the high degree of structure ordinarily present in a black like HAF black is destroyed. We believe this viscosity change leads to the downward displacement of the stress-strain curves (Figures 10, 11). This is an advantage of attrited blacks which is clearly apart

TABLE VI—EFFECT OF ATTRITED HAF BLACK AND GLYCEROL IN SBR COMPOUND

Cured with peroxide 20 minutes at 300°F.

Condition of black	Ball Milled		Standard	
Glycerol, php	——	3.0	——	3.0
Modulus at lbs./in.²				
100%	160	175	190	175
300%	475	670	690	725
500%	1400	1850	1540	1580
700%	2350	3125		
Tensile strength, lbs./in.²	2750	3125	2025	1925
Per cent elongation	785	700	680	630
Shore hardness	53	55	58	55

TABLE VII—EFFECT OF SELECTED HYDROXY COMPOUNDS SUBSTITUTED FOR GLYCEROL IN SBR-BALL MILLED HAF SYSTEMS

Cured 20 min. at 300°F.

ADDITIVE	Modulus, lbs/in² 200%	300%	500%	Tensile strength lbs/in²	Elongation, per cent	Shore Hardness
Catechol (1,2 dihydroxyphenol)	No Cure					
pyrogallol (1,2,3 trihydroxyphenol)	No Cure					
phloroglucinol (1,3,5 trihydroxyphenol)	No Cure					
water	310	475	1075	2250	825	51
lauryl alcohol (3 moles)	215	480	1335	3050	760	—
NO ADDITIVE (control)	300	500	1185	2550	855	50
diethylenetriamine	325	500	925	1875	740	58
n-propyl alcohol	310	520	1260	2500	790	50
resorcinol (1,3 dihydroxyphenol)	350	530	1110	3015	860	58
phenol	350	550	1280	2590	790	52
n-propyl alcohol (3 moles)	325	550	1350	2830	810	51
lauryl alcohol	330	575	1490	3240	800	48
water (3 moles)	350	580	1400	2765	790	50
hydroquinone (1,4 dihydroxyphenol)	440	750	1720	3150	720	58
trimethylene glycol (propandiol-1,3)	605	1215	3140	4225	590	68
GLYCEROL	710	1500	3625	4500	590	58
ethylene glycol	900	1750	—	3500	470	62
1,2,6 hexanetriol	985	1900	—	3615	455	62

and distinct from their reinforcing action in the vulcanizate.

Increased length and strength of SBR vulcanizates containing attrited blacks are evident at normal filler loading levels (thirty volumes), but become more pronounced when carbon black concentration is increased to forty, fifty or sixty volumes. Test results are shown in Table VIII for SBR systems with standard and ball milled HAF blacks. Data are presented for both heat treated systems and for control systems which are not heat treated. The enhanced tensile properties which are shown in Table VIII to result from the use of attrited black are illustrated in Figure 14 by plotting tensile product (tensile strength x elongation) curves. These curves refer to samples before (solid lines) and after (dotted lines) heat treatment. They indicate that concentration of attrited black can be increased by 15 to 25 volumes

TABLE VIII—EFFECT OF FILLER CONCENTRATIONS ON THE TENSILE PROPERTIES OF SBR WITH STANDARD AND ATTRITED HAF BLACKS

Cured 30 min. at 300°F.

Volumes of Black	20		30		40		50		60	
Condition of Black	Std.	B.M.	Std.	B.M.	Std.	B.M.	Std.	B.M.	Std.	B.M.
Not Heat Treated										
Modulus at lbs/in²										
100%	315	260	605	360	1105	495	1610	680	0	960
200%	915	580	1835	850	3000	1400	0	2000	0	2770
300%	1800	1190	3180	1755	0	2690	0	3450	0	0
400%	2825	2180	0	2935	0	3890	0	0	0	0
Tensile Strength, lbs/in²	3315	3330	3915	4380	3340	4110	2625	3750	1975	3415
Per cent elongation	445	500	375	520	235	425	170	355	105	270
Shore hardness	58	56	68	62	78	70	82	77	90	82
Electrical Resistivity, ohm.cm.	2.9×10^{11}	3.8×10^{10}	4.7×10^{7}	8.6×10^{7}	4.3×10^{7}	5.7×10^{7}	3.7×10^{7}	4.6×10^{7}	4.1×10^{5}	5.2×10^{7}
Heat Treated										
Modulus at lbs/in²										
100%	390	165	695	230	1430	335	2000	550	0	685
200%	1335	330	2215	625	0	965	0	1150	0	2000
300%	2550	735	3730	1585	0	2195	0	3450	0	0
400%	0	1510	0	3010	0	3720	0	0	0	0
Tensile Strength, lbs/in²	3025	3620	3925	4545	3210	4280	2510	3915	2040	2765
Per cent elongation	330	600	305	555	190	470	135	350	75	260
Shore hardness	59	48	67	55	75	60	83	66	90	73
Electrical Resistivity, ohm.cm.	3.9×10^{14}	9.1×10^{15}	3.8×10^{13}	8.6×10^{14}	1.1×10^{8}	2.3×10^{14}	4.1×10^{7}	4.3×10^{13}	3.1×10^{7}	2.2×10^{10}

TABLE IX—EFFECT OF FILLER CONCENTRATION ON THE DYNAMIC PROPERTIES OF SBR WITH STANDARD AND ATTRITED HAF BLACKS

Cured 30 minutes at 300°F.

	Not Heat Treated									
Volumes of black	20		30		40		50		60	
Condition of black	Std.	B. M.	Std.	B.M.	Std.	B.M.	Std.	B. M.	Std.	B. M.
Dynamic properties in SBR										
$\eta f \times 10^{-6}$, poises x cps	2.05	1.26	3.62	2.27	6.84	4.32	11.5	6.18	17.8	10.6
$K \times 10^{-7}$, dynes/cm²	6.98	6.29	10.2	6.87	14.6	10.4	20.4	13.3	30.9	18.1
per cent relative damping	25.3	18.0	29.9	28.0	37.4	33.9	43.6	37.1	44.2	45.0
	Heat Treated									
Volumes of black	20		30		40		50		60	
Condition of black	Std.	B. M.	Std.	B.M.	Std.	B.M.	Std.	B. M.	Std.	B. M.
Dynamic properties										
$\eta f \times 10^{-6}$, poises x cps	1.75	1.47	3.24	1.96	5.75	2.99	10.0	4.70	16.5	7.65
$K \times 10^{-7}$, dynes/cm²	7.40	5.33	9.34	6.64	13.8	8.15	18.4	10.9	28.6	14.0
Per cent relative damping	20.9	24.0	29.2	25.4	34.1	30.7	42.3	35.1	44.4	42.4

over that of standard black before tensile product is reduced to typical values ordinarily obtained for standard black compounds. Unusually high values of tensile product are obtained with the attrited black. These values approach 200 x 10^{-4}. The possible effect of this result on abrasion resistance *(17)* is noteworthy. Finally, the heat treatment response in Figure 14 is interesting. The detrimental response with standard black indicates a disadvantage which may describe the fate of SBR in conventional Banbury mixing. More will be said about this later in the section on heat treatment responses.

Shore hardness data in Table VIII stress the increased softness obtained with attrited black. Electrical resistivity values in this table indicate that attrited black is dispersed fairly uniformly, by the action of heat treatment, even at high levels of loading. This result agrees with the concept of increased black activity; pigment-polymer associations are held as a requisite for immobilization of black particles which otherwise might recluster to form carbon-carbon associations in the course of the vulcanization reaction *(18)*.

Dynamic Qualities Softened

The dynamic properties of SBR are improved with attrited blacks. Data in Table IX give results obtained from tests with the modified Yerzley oscillograph *(5)*. The compounds used in this work were the same as those in the carbon concentration study reported above. A plasticizing oil (Sun Circo Light, 10 php) was added to the base formulation to facilitate the testing of the highly loaded samples. The use of attrited black decreases both ηf and K. Changes in relative damping, though much smaller than for the corresponding butyl systems *(2)*, indicate that reduced internal viscosity and increased dynamic softness are realized in attrited black systems without loss in over-all rubberlike properties. Heat treatment ren-

TABLE X—FLEXING PROPERTIES OF SBR WITH STANDARD AND ATTRITED HAF BLACKS

Cured 30 minutes at 300°F.

	Not Heat Treated				Heat Treated			
Volumes of Black	30	30	40	40	30	30	40	40
Condition of Black	Std.	B.M.	Std.	B.M.	Std.	B. M.	Std.	B. M.
Static compression, inches	0.186	0.261	0.151	0.215	0.236	0.324	0.169	0.308
Initial dynamic compression, inches	0.131	0.201	0.096	0.171	0.181	0.286	0.113	0.266
Dynamic drift, inches	0.013	0.012	0.018	0.021	0.024	0.021	0.011	0.050
Compression Set, per cent	3.2	3.8	6.0	5.1	7.0	11.8	3.5	15.0
ΔT in degrees C.	13.0	12.0	20.0	16.0	17.0	15.0	17.0	21.0

TABLE XI—EFFECT OF ATTRITED HAF BLACK IN NATURAL, ACRYLONITRILE, AND CHLOROPRENE RUBBER

Compounds cured 45 minutes at 287°F.

Elastomer	Smoked Sheet		Hycar OR 15		Neoprene GN	
Condition of black	Standard	Ball Milled	Standard	Ball Milled	Standard	Ball Milled
Modulus at lbs./in.^{2}						
100%	625	350	650	400	860	600
200%	1560	875	1810	950	2300	1550
300%	2610	1755	3000	2000		2565
400%		2800		3065		
Tensile Strength, lbs./in.^{2}	3465	3505	3775	4240	2780	3065
Per cent Elongation	380	470	405	565	280	380
Dynamic properties						
$\eta f \times 10^{-3}$, poises x cps	2.45	1.32	6.77	5.33	9.05	5.76
$K \times 10^{-7}$, dynes/cm^2	11.2	6.46	16.4	13.7	17.1	13.6
Per cent relative damping	19.6	18.3	33.8	32.3	41.4	34.5
Electrical resistivity, ohm cm.	2.0×10^5	8.3×10^9	5.1×10^9	7.1×10^{10}	1.7×10^9	2.3×10^{10}
Tensile product x 10^{-4}	131.7	164.7	152.9	239.5	77.8	116.5

ders some further improvement in the dynamic qualities of the vulcanizates.

Flexometer Tests

Goodrich flexometer tests were run with above samples containing thirty and forty volumes of black, respectively. Tests were run at 100°C. using 145 lbs./in.^{2} load with a ⅛ inch stroke. In the absence of heat treatment, no sacrifice in flexing properties results from the use of attrited blacks (Table X). No increases in dynamic drift, compression set, or ΔT are obtained, despite the fact that these samples sustain a larger imposed compression due to their greater softness. Heat treatment renders these attrited black samples too soft for the testing conditions. Therefore, in testing, severe static and dynamic deformations lead to relatively high values for compression set. This difficulty would probably be corrected if the stiffness of the vulcanizates were increased by omission of the plasticizing oil. Clearly, there is no evidence in the ΔT values for intrinsic hysteretic failure with heat treated attrited black systems.

Cyclic extension-retraction tests run at constant extension of 150 per cent with the Instron tester demonstrated another advantage for attrited blacks in SBR. Curves in Figure 15 show, respectively, the first and sixth extension-retraction cycles for vulcanizates with standard and ball milled HAF blacks. The first cycles are indicated by solid lines, and the sixth cycles by dotted lines. Open circles denote standard black, and solid circles denote ball milled black.

Figure 16 shows that decay of stress on prestressing (the Mullins effect) is less with attrited than with standard black. The plot is constructed using values taken from the extension curves of each extension-retraction cycle. The zero point refers to the original extension and numbers refer to subsequent extension-retraction cycles. Stress decay is expressed in terms of the absolute loss in modulus at 125 per cent elongation. The total changes in going from the original to nearly steady state condition amount to 43 and 29 per cent for standard and attrited black systems, respectively. The substitution of carbon-polymer attachments for the weaker carbon-carbon attachments is suggested as an explanation for the superior performance of attrited black compounds in this test.

The heat treatment of SBR-carbon black mixtures generally leads to vulcanizates with increased modulus and reduced extensibility. With channel black, a thermal interaction response, similar to that obtained with butyl, but much smaller in magnitude, is obtained *(3)*. Care must be taken, however, to limit the heat treatment, both with respect to time and temperature, if resinification and related, undesirable oxidative effects are to be avoided.

Unusual Response

In contrast to butyl, the thermal interaction of SBR occurs, even if only to a limited extent, with furnace as well as channel blacks. Table III shows that conventional heat treatment responses are obtained with standard HAF black, whether or not glycerol is present in the compound. If 300 per cent modulus is taken as criterion, resultant modulus increases are less than 15 per cent. In the absence of glycerol, the heat treatment of SBR with attrited HAF black (Table III) yields much greater thermal interaction responses. The enhanced activity of oxy blacks is thus confirmed, the modulus at 300 per cent being increased this time by 48 to almost 100 per cent, depending on the cure.

The presence of glycerol in mixtures of SBR with attrited black, shown in Figure 17, leads to an unexpected reversal in the heat treatment response. Modulus is decreased (downward pointing arrows);

TABLE XII—EFFECT OF MIXING CONDITIONS ON PROPERTIES OF NATURAL RUBBER WITH ATTRITED HAF BLACK

Compounds Cured 20 Minutes at 287°F.

Mixing Conditions (see below)	1	2	3	4	5
Modulus at lbs./in.^{2}					
100%	330	430	360	415	415
200%	780	935	825	935	945
300%	1475	1715	1600	1790	1770
400%		2665	2600	2910	2745
500%				3975	
Tensile Strength, lbs./in.^{2}	2360	3380	3390	4235	3765
Per cent Elongation	400	480	490	530	510
Shore Hardness	57	61	59	64	63
Dynamic Properties					
$\eta f x 10^{-6}$, poises x cps	3.20	3.02	2.05	1.92	1.84
K x 10^{-7}, dynes/cm^2	8.97	9.80	7.68	8.63	8.40
Per cent relative damping	30.0	26.5	23.3	19.7	19.6

Mixing Conditions

1) Polymer broken down prior to addition of black.
2) Like 1), except glycerol (3.0 php) added with black.
3) Polymer not broken down prior to addition of black.
4) Like 3), except glycerol (3.0 php) added with black.
5) Concentrated masterbatch prepared.

decrease is largest in the earliest cure, and tends to disappear in the longest cure. Heat treatment of the same system without glycerol (upward pointing arrows) produces increases in modulus which become larger as the cure time is increased. Heat treatment of the two systems therefore leads to a single level for the modulus. This is a surprising result for which no explanation can be given yet.

Examination of columns five and six in Table III reveals no difference, essentially, in the stress-strain properties of heat-treated SBR-attrited black compounds respectively prepared with and without glycerol. Heat treatment was carried out by hot milling the polymer-carbon black masterbatch for ten minutes at 300° to 310°F. on an open mill. Stearic acid, and glycerol, when used, also were added in the masterbatch. This is a mild form of heat treatment. It produces results which tend to be similar to those obtained from Banbury operation, where the times generally are shorter (after initial incorporation of the black) but the stock temperature is higher.

Similar Effects Obtained

Effects similar to those in fully cured butyl and SBR compounds are obtained when attrited blacks are used in other elastomers. Results shown in Table XI illustrate vulcanizate changes resulting from the substitution of attrited for standard HAF black in natural, acrylonitrile-butadiene, and chloroprene rubbers. The compounds were cured for 45 minutes at 287°F. As already stated, cure retardation problems were not encountered with these polymers. The use of glycerol was not only not required, but, except in the special case described below, produced no significant improvement in the quality of the vulcanizates.

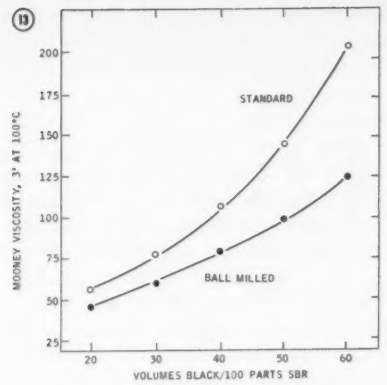
In the work done with natural rubber, difficulty was experienced in reproducing test results with attrited black compounds. Tensile strength, for example, was found to vary considerably in similar batches prepared under seemingly identical conditions, but at separate times. A final set of experiments was undertaken, therefore, to determine what effect might be obtained if the mixing procedure were purposely changed. Accordingly, natural rubber was mixed with attrited HAF black under the following conditions:

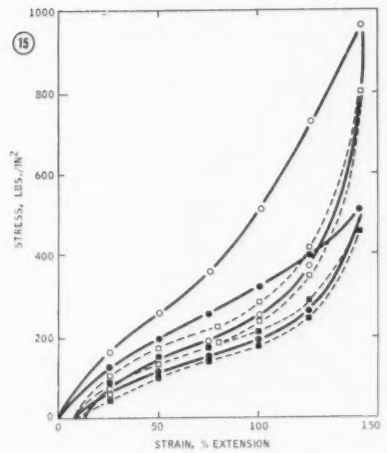
Five Conditions

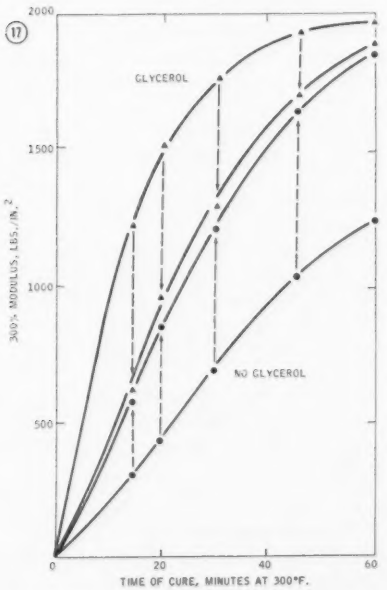
Condition 1. The raw rubber was premasticated by passing it once through a tight 6 inch by 12 inch mill (0.007 inch clearance) at 80° to 90°F. Then the rubber was immediately banded, and milled continuously with active rolling bank until the band was smooth. This required three to four minutes. Then cooling water—not used until this time—was turned on, and the addition of black was initiated. Normal mixing procedures were followed to complete preparation of the batch.

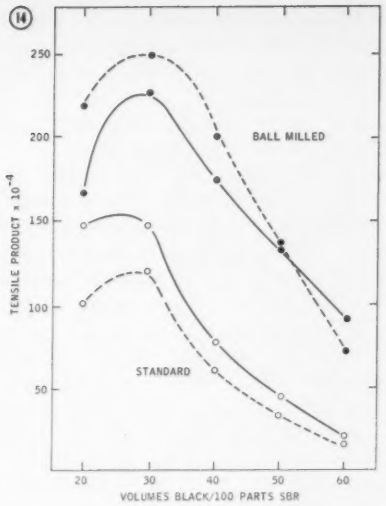
Condition 2. The procedure of Condition 1 was followed in every detail, except that glycerol (3.0 php) was added with first additions of the black.

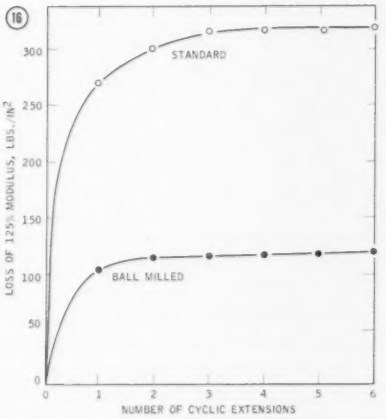
Condition 3. The raw rubber was premasticated and banded as in Condition 1. Cooling water, however, was turned on and the black addition was











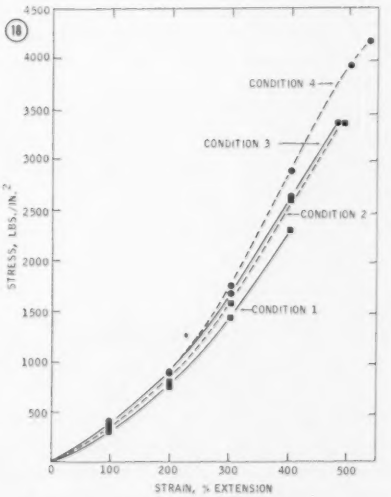


FIG. 13—Curves compare Mooney viscosity for SBR systems with varying concentrations of standard and ball milled HAF blacks; FIG. 14—Tensile product of SBR vulcanizates compared with standard and ball milled HAF blacks. Solid lines: control; dashed lines: heat treated; FIG. 15—Cyclic stress-strain curves are shown for SBR vulcanizates with standard and ball milled HAF blacks; FIG. 16—Curves show loss of modulus on cyclic extensions for SBR vulcanizates with standard and ball milled HAF blacks; FIG. 17—Effect of heat treatment on modulus of SBR-attrited HAF black systems with and without glycerol; FIG. 18—Effect of mixing procedure on stress-strain properties of natural rubber vulcanizates with attrited HAF blacks.

started immediately, while the band was still rough. The polymer was not broken down as in Condition 1. After all the black was added, milling was continued for four minutes, the time consumed in previous cases to effect polymer breakdown prior to the addition of black. Normal mixing procedures were followed then to complete preparation of the batch.

Condition 4. The procedure of Condition 3 was followed in every detail, except that glycerol (3.0 php) was added with first additions of the black.

Condition 5. The procedure of Condition 2 was followed in every detail, except that the black charge was increased from 50 to 100 php in the preparation of the original masterbatch. The masterbatch was diluted next with virgin rubber to obtain the required black loading (50 php). The virgin polymer used for dilution was premasticated and banded as in Condition 3. Normal mixing procedures were followed thereafter to complete preparation of the batch. All the compounds were cured for 20 minutes at 287°F. in this condition.

A Dispersion Problem

The problem of attrited black utilization in natural rubber is apparently a problem of dispersion—in its broadest sense. If mixing is more severe, as in Conditions 3 and 4, better dispersion of the black apparently is obtained. The improved vulcanizate quality which therefore results is seen by comparing the curves for Conditions 1 and 3 on the one hand, and 2 and 4 on the other, in Figure 18. Table XII contains a detailed compilation of all the data obtained from the experiments just described. Concentrated masterbatching (Condition 5) is another method for increasing the severity of the milling action. Good utilization of the black is therefore provided.

Dispersion appears to be aided also by the use of additives. Glycerol, in mixtures of attrited black with Hevea, is cited as an example. Profound cure effects, encountered with SBR, are not obtained in these systems. In the writer's opinion, the increases in vulcanizate length and strength, which are obtained without other significant changes in the stress-strain curve (Figure 18), are unmistakable evidence of improved dispersion.

Summary

The cure of SBR is severely retarded in compounds with attrited blacks. This retardation is not found in butyl, natural, and acrylonitrile-butadiene polymers containing the same blacks, but is associated with the sensitivity of SBR to acidity on the part of the black. The cure of SBR-attrited black compounds is sharply activated when glycerol or other aliphatic polyols are added in the compound. The glycerol activation effect is unique with respect to both the polymer and the black. It is not obtained with SBR containing standard blacks, or with other elastomers, regardless of the black. Cure retardation and glycerol activation effects are specially pronounced in attrited black-SBR systems which are cured with sulfur. A combined reinforcement-vulcanization reaction is therefore envisioned to include the polymer, the black, sulfur, and glycerol as the reactants.

When the compounds are properly cured with glycerol, attrited blacks lead to SBR vulcanizates with improved properties. The results are generally similar to those observed with butyl. Tensile strength and extensibility are increased. The vulcanizates are softer, evident from reduced modulus and Shore hardness. Dynamic properties are improved; both dynamic modulus and internal viscosity of attrited black-SBR vulcanizates are less than obtained ordinarily with standard blacks. The increased activity of attrited black leads to greater heat treatment responses when glycerol is not present in the compound. The heat treatment of SBR containing both attrited black and glycerol results in a reversal of the normal heat treatment response. The reason for this reversal is not understood.

Attrited blacks in natural, acrylonitrile-butadiene, and chloroprene rubbers give results similar to those in butyl. Cure retardation and glycerol activation effects are not encountered with these elastomers.

Acknowledgment

The author is grateful to F. P. Baldwin, I. Kuntz, and J. Rehner, Jr. of these laboratories for helpful discussion relating to the material in this paper, and for review of the manuscript. He most gratefully acknowledges the assistance of J. C. Scarpa in carrying out the experimental work.

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EDITORIAL

Competitive Progress

► Although consumption of new rubber, the major barometer of the rubber industry, fell off by some 75,000 long tons in 1960, in comparison with the previous year, the industry achieved a total of six new records in consumption and production, as pointed out in the annual year-end statement of the Rubber Manufacturers Association. These included the production, consumption and exports of synthetic rubber, the ratio of synthetic to total new rubber use, and shipments of passenger car replacement tires and passenger, truck-bus and farm tires. The specific figures will be found in the Review and Preview Section of this issue.

We respectfully call our readers' attention to this special section, a feature of our January issue for many years past. A great many of the 1960 and 1961 estimates in this special report are our own, but the report also includes statements of fact and opinion from a number of outstanding authorities in all the important branches of the rubber industry. In general, these statements, which cover a good deal of ground, are on the optimistic side for 1961, insofar as the rubber industry is concerned. There is little doubt that additional records of some kind will be established in the next twelve months, especially in synthetic rubber and in the shipment of replacement passenger tires.

Among the statements referred to above is one by Harvey Firestone, chairman of the Firestone Tire & Rubber Co. Mr. Firestone states that "confidence" is the keyword in the Firestone vocabulary for 1961. But the portion of the statement we like best is devoted to competition. Along these lines he says: "During its most competitive years the rubber industry has made its greatest progress. The most rapid advances in technology to meet marketing challenges have taken place when competition was the strongest."

The history of the industry bears out this statement strongly and since the climate for 1961 will certainly call for competitive conditions up and down the line, especially in the field of synthetic rubber, we confidently look forward to "rapid advances in technology." Spearheading these technological advances will be new types of polyisoprene and polybutadiene rubbers. Before the year is out, however, we predict that at least one new major polymer will enter the market arena.

Various appellations have been applied to the coming year of 1961, including "Sober Sixties," "Profitless Prosperity," and "Year of the Costs." Where the rubber industry is concerned, keeping in mind Mr. Firestone's statement, we believe it will be a year of "competitive progress." It should prove to be healthy progress.

General Tire Offers Licenses For Its Oil-Extended Rubber

► General Tire and Rubber Co., Akron, Ohio, has been officially awarded a U.S. patent for its High-Mooney oil-extended rubber, and M. G. O'Neil, company president, immediately made the announcement that licenses under the patent will be awarded to the entire rubber industry. The official recognition of General's ownership of the patent followed a reversal of the U.S. Patent Office Board's 1957 rejection of the company's bid for a patent. District Judge Alexander Holtzoff of the U.S. District Court of the District of Columbia had overruled the board's decision. The controversy surrounding the High-Mooney process dated back to November 20, 1950, when General Tire had originally applied for a patent on the invention developed by a team of General Tire scientists in the company's Research and Development Division in Akron. Last June 10 Judge Holtzoff ruled in effect that General Tire was entitled to a patent on its High-Mooney process as it was a new invention, despite arguments by government attorneys that the company should be denied a patent.

Universal Usage

Since 1958, use of the invention by the rubber industry in making tire treads has been almost universal. During 1959, 1.4 billion pounds of oil-extended rubber were produced within the industry in the United States, and production in 1960 is estimated to be far in excess of this amount. Further, it is estimated that during 1959, at least 75 per cent of the total oil-extended rubber produced was used in the making of tire treads. Oil-extended rubber is presently selling for approximately 5.25c per pound less than standard 50-Mooney styrene-butadiene rubber.

Best Paper Award

► The Division of Rubber Chemistry, American Chemical Society has named Robert M. Murray and J. Donald Detenber (DuPont) as the next recipients of the Best Paper Award. The Messrs. Murray and Detenber presented their paper "A Study of First and Second Order Transitions in Neoprene" at the Fall Meeting of the Division held on September 13 to 16, 1960. The award will be presented to the co-authors at the forthcoming Spring Meeting of the Rubber Division to be held in Louisville, Ky.

"Now that a patent has been granted to General Tire covering the oil-extended rubber," said Mr. O'Neil, "we expect to charge a reasonable royalty for a license to other companies who want to use our invention." Mr. O'Neil also commented that "This discovery is estimated to be saving the motoring public in excess of $60 million per year in its purchases of tires and rubber products. It is also estimated that continued widespread use of it by the Rubber Industry will result in total savings to the public of hundreds of millions of dollars during the coming decade."

Discovery of the company's High-Mooney process evolved from one of the early research assignments for Gilbert Swart, General Tire research director, and his research and development staff, during a search for proper materials to produce floor matting for automobiles and other industrial rubber products requiring a similar type composition. The research on this project involved the scientific blending of synthetic rubbers with various selected oils, and the team found that the end-product possessed surprisingly excellent properties.

"Our research staff was intrigued," said Mr. O'Neil. "They began to conduct extensive laboratory tests to delve deeper into the whole technology. Time and money were appropriated by the company to allow our research and development people to study every phase of the situation. In time, based on what they had learned in their research on automobile floor matting, our chemists developed an oil-extended synthetic rubber which they believed might be superior to the conventional synthetic rubber being used in the making of tire treads."

The new rubber was subjected to exhaustive testing and shattered the preconception that rubber processing additives in general and large amounts of oil in particular had a deteriorating effect on rubber quality. "We realized," said Mr. O'Neil, "we had discovered a new rubber of outstanding qualities." Further development resulted in a greater number of tires being produced at a substantially lower cost and capable of 18 per cent longer wear.

Meanwhile, the discovery itself was at first allowed and later rejected by the U.S. Patent Office on the grounds it was not a patentable invention. Research on oil-extended rubber for tire treads, based to a substantial degree upon the information disclosed by General Tire to the Federal government, was immediately intensified throughout the industry at a time when the government was the owner of the synthetic rubber plants. General Tire offered the invention to the government at the time of the Korean War and information on the invention was published as early as 1951.

Chicago Hears Islinger On Elastomers in Space

► "The Role of Elastomers in the Aero-Space Age," was the subject of a talk given by J. S. Islinger (Armour Research Foundation) to the Chicago Rubber Group, on November 18, 1960, at the Furniture Club in Chicago, Ill. According to Mr. Islinger, the amazing developments in the rubberlike material field in the last five to ten years can be attributed to the increasing demands of both speed and altitude of recent manned aircraft and unmanned aircraft missiles and satellites. He explained that in high performance aircraft the elastomers used are exposed to extremely high temperatures, such as the heat generated internally within the system, such as a high performance engine or hydraulic system, and heat generated by friction at supersonic speeds.

If such aircraft, Mr. Islinger pointed out, are based in arctic climates, or if they fly at extremely high altitudes at relatively slow speeds, all rubberlike items would be subjected to fairly low temperatures. The Armour research engineer explained that many of the elastomer materials are in contact with, and must be resistant to, another environment composed of all the various fluids such as the fuels or propellants, the hydraulic fluids, lubricants, and others which are required for system operation.

Other Conditions

In satellites and space vehicles, Mr. Islinger stated, other environmental conditions must be taken into consideration. According to the speaker, these include the effects on elastomers of radiation, extremely high vacuum conditions, and the combined effects of these environments with the others, including the thermal environment. He stressed that when these orbiting and interplanetary vehicles are manned, these elastomer materials must be called upon to aid in maintaining a habitable environment within the cabin of such vehicles and they must not become toxic or emit objectionable odors or in any other way cause discomfort to the occupant.

At the conclusion of his talk, Mr. Islinger showed a motion picture on flights made by the North American X-15 airplane, which is being used in research flights to study the problems likely to be encountered in flight beyond the atmosphere.

J. S. Islinger (Armour Research Foundation), on left, discusses his Chicago Rubber Group talk on "The Role of Elastomers in the Aero-Space Age," with T. C. Argue (Roth Rubber), vice-president of the Chicago Rubber Group.

Shell Plans New Plant

► Shell Chemical Co., New York, N. Y., has announced that it will build a new polypropylene plant with an initial capacity of 80 million pounds a year near Woodbury, N. J. The plant will utilize a new process developed in a four year, multimillion dollar research program conducted at Shell Development Co.'s research center at Emeryville, Calif. The Plastics and Resins Division of Shell Chemical will build and operate the new plant. A new research center and technical service center will also be constructed at the manufacturing plant, in order to provide complete technical assistance for makers of industrial and consumer products.

Cooney Rejoins Egleston

► Edward C. Cooney has rejoined the William D. Egleston Co., Cambridge, Mass., after an 11-year absence, and will serve as manager of the company. A 1931 graduate of Boston University, Mr. Cooney also attended the University of Puerto Rico. His experience includes 13 years with the Bell System as sales supervisor and manager. Before rejoining the Egleston Company, he spent seven years with the New Jersey Zinc Co. as manager of their pigment office in Boston, and four years in metal sales in New York.

Hewitt-Robins Acquisition

► The board of directors of Hewitt-Robins Inc., Stamford, Conn., and the Union Chain and Manufacturing Co., Sandusky, Ohio, have approved the acquisition of Union Chain by Hewitt-Robins, subject to approval by the stockholders of Union Chain. The acquisition will be in return for common stock in Hewitt-Robins, and Union Chain will be operated as a division, with E. F. Emmons, now president of Union Chain, heading the division as its president. Hewitt-Robins' line of industrial products includes material handling and processing equipment, conveyor belting, industrial hose and power transmission machinery. Union Chain manufactures conveyor and power transmission chain and sprockets in its plant at Sandusky, Ohio. The acquisition is expected to increase Hewitt-Robins sales about 10 per cent.

Introduces Slim Sidewall

► Tire designers at U. S. Rubber Co., New York, N. Y., are hoping that the introduction of new white sidewalls an inch and a quarter wide by Chevrolet will herald an industry adoption of the new style being pioneered by the company. The Monza, a new luxury version of the Corvair coupe, will feature the slim sidewall on the car's 13-inch tire.

German Rubber Conference Themes:

Synthetic Rubbers and Fibres

An evaluation of the papers presented at the International Rubber Conference in Berlin on October 4-8, 1960, written exclusively for RUBBER AGE

By Dr. WILLIAM C. WAKE
Rubber & Plastics Research Association of Great Britain
Shawbury, England

The themes of the 1960 conference of the Deutsche Kautschuk Gesellschaft, held October 4-8 in Berlin, were synthetic rubbers and man-made fibres. The two plenary lectures illustrated this two-fold approach since the first dealt with the development of synthetic rubber since 1930 (Dr. P. Baumann) and the second with the development of man-made fibres (Dr. A. Ebert). This dichotomy continued throughout the first day for, after the plenary lectures, the conference split into two parts, one part dealing with elastomers and the other with fibres. The word "halves" was not used, for the attendance at the paired sessions did not justify its use and there was as a rival attraction an exhibition of apparatus and machinery and also one of products using both rubber and textiles. In addition, the program organizers had arranged outings for the ladies. The business meeting of Tuesday, October 4, the press conference, and the reception by the Berlin Senate were reported in the November, 1960 issue of RUBBER AGE, and it now remains only to try to interpret some part of the Berlin meeting to American readers.

The first plenary lecture reviewing synthetic rubber development did not, in fact, devote much time to the earlier history of the industry but concentrated on the elastomers now available, their 1959 production and probable trends. The lecturer showed how analytical practice had kept pace with synthetic developments. For example, earlier molecular weight determinations by viscosity measurements were subject to unknown errors by chain branching and generally by shape. Now that there is more control of shape and distribution, combinations of molecular weight measurements by different means enable the shape and distribution to be assessed. Similarly, control of the mode of addition has been matched by the development of infrared spectroscopy which can measure the contributions of 1,2 and 1,4 as well as *cis* and *trans*, to the total polymer. Referring to work carried out at Hüls, and therefore presumably characteristic of modern German production of cold SBR rubber, Dr. Baumann quoted the following data:

$\overline{M}_w$ = 500,000 (by light scattering and ultra-centrifuge).

$(\overline{M}_w/\overline{M}_n) - 1 = 5$ (one peak only in the distribution).

About 2.4 cross-links per macromolecule.

Interest partly centered on the newest of rubbers, ethylene-propylene copolymer (AP rubber in German) for which he gave:

$\overline{M}_w$ = 207,000

$(\overline{M}_w/\overline{M}_n) - 1 = 5.5$

The major interesting feature of Dr. Ebert's plenary lecture on the development of man-made fibres for industrial applications was his demonstration of the fact that this had taken a different course in West Germany than it had in the United States. This, while it is probably well known to the economic advisors of the textile companies, may not have been fully appreciated by the technologists to whom it was addressed.

The point is well made in Figure 1 which is based on two of the slides shown by Dr. Ebert. (Note that the scale for U. S. is one-tenth of that for West Germany to bring the graphs into the same diagram.) The history with which Dr. Ebert was concerned is that of the last ten years. The survival of rayon, and indeed the growth of its use in Germany, was attributed to the progressive modification of the rayon; conditioned yarn strength has increased by 50 per cent and wet strength by 80 per cent and conditioned tire cord strength by 75 per cent. In the earlier years of the period, improvements were achieved by spinning from doped baths or with doped viscose, initially 1 to 3

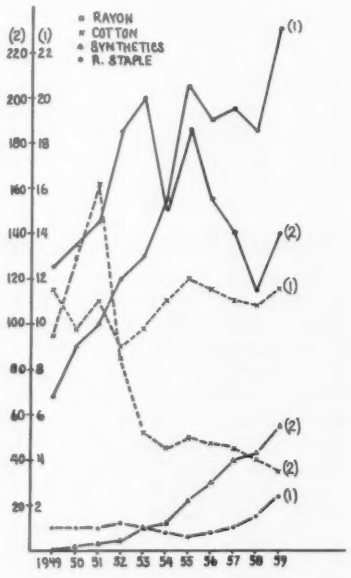

Figure 1—Fibre Consumption in (1) West Germany and (2) in the United States.

per cent, based on cellulose of aliphatic amines and later polyethylene oxides; but more recently still, even better results have been obtained without additions of this nature. The newest yarns are bean-shaped in cross-section and seem to contain a larger number of smaller crystallites though the overall crystallization is not much altered.

Some interesting observations on nylon versus Perlon draw attention to the importance of the antioxidants added to these fibres, and it is obvious that the author feels that Perlon may yet win a large share of the tire cord market. He also points out that compared with the newer rayons, nylon carries a higher price whether reckoned on weight or on strength units, and that it must also carry the cost of hot stretching. One might add here that the direct cost of hot stretching is not the end of the matter, for it is usual to put in some of the hot stretch after a first coating of the adhesive and before a second coat. This double coating is both a trouble and an expense.

The end part of this second plenary lecture reviewed the uses of man-made fibres in products other than tires, and the speaker's remarks were linked to the exhibition of such products in the main circulation space of the Kongresshalle.

Both these plenary lectures were simultaneously translated into English and French and monaural earpieces were provided. Thereafter presentation normally followed in the native language of the speaker but a surprising amount of the discussion was in English. There was, however, a pattern in this and it became obvious that much discussion was, in fact, with the speakers' compatriots; only our hosts, for the main part, ventured outside their mother tongue.

An Historical Paper

Before leaving the historical field it is convenient here to review the paper presented on Thursday on the initial stages of scientific research on natural rubber. This is a truly historical paper presented by Dr. F. Kirchhof, a name perhaps better known to those who, unlike the present reviewer, were active in rubber research before the war. Dr. Kirchhof quotes J. P. Joule's paper (1859) showing the force exerted for a 400 per cent extension and the corresponding temperature change. It seems that this was not christened the "Gough-Joule effect" until 1930 when a German, Lothar Hock, so referred to it. Turning next to the discovery of vulcanization, the paper refers to Goodyear's earlier work and its relation to the patent granted to Hayward (1839). Interestingly, there is also recalled the fact that black powder (*i.e.*, charcoal, nitre, sulphur) was used by the natives of Central and South America mixed with latex and dried down onto their textiles and heated by the sun. From vulcanization to latex analysis starting with Michael Faraday (1826) and thence to the unravelling of the chemical nature of rubber in which, of course, Harries is the great name—commemorated at this meeting of the D.K.G. by the award of the Carl Dietrich Harries Plaque to one of the plenary lecturers and a colleague. With the notable exception of Goodyear, this was essentially an exercise in European science as the impressive list of references testifies. Dr. Kirchhof's presentation ended with a bonus not available in the printed version—a series of slides with the photographs of many of the workers recalled in his review; bearded Victorian worthies or their Germanic counterparts. The printed version concludes with a quotation, "Our lives are the poorer when we lose the horizon of history."

Table 1—Constitution of Polybutadienes

	cis 1,4	*trans 1,4*	*1,2*	*gel*
Diene Rubber (A, J and F) (lithium butyl polymerized)	32–35%	ca 60%	7.5%	0
Polybutadiene B (American source, Al/Ti catalyzed)	95	3	2	1
Hüls II (Al + heavy metal)	98	1	1	0
Hüls I	85	13	2	0

Synthetic Elastomers

Seven papers under the general heading of elastomers were given after the plenary lectures on the first day in the main auditorium. Some of these were designed to report to a German audience the state of development work and technology elsewhere and their general content is known, or is otherwise available, to the American technologist. Three of these papers are reported on, two of them at this point and a third later in the review. Others were concerned with ethylene copolymers which are also mentioned later. Of immediate interest is the question, "How do the German polybutadienes compare with the American?" Information on this can be obtained by comparing Dr. Engel's paper with that of Drs. Alliger, Johnson and Forman or with other sources. Table 1 indicates, for example, structural differences.

It is obvious from Table 1 that the American and German papers are, in fact, reporting polymers of different constitution and therefore of different properties, though polybutadiene B, used by Dr. Engels to compare with Hüls II, was of American origin and is clearly of the same general type as Hüls II. Diene rubber is amorphous and therefore has exceptionally good low-temperature properties — better than natural rubber though probably not better than non-crystallizing natural rubber; it is designed for use in tires but its processing behavior is not discussed. However, the suggestion of blending with natural rubber and thereby obtaining the processing characteristics of the latter, may mean that, in spite of its amorphous structure, it does not extrude well on its own. Hüls II, a linear polymer, is described as "middling to bad" for extrusion, a description applied equally to Hüls I even though this is amorphous. Technology seems to indicate 50-50 blends with natural rubber for both Hüls II and Diene rubber, rather than blends with SBR.

The ethylene copolymers dealt with were those with propylene and vinylacetate. The possibility of producing a usable rubber from the former hinges on obtaining a suitable cross-linking reagent and the papers by Drs. Natta, Crespi and Bruzzone, by Drs. Canevari and Morando, and also the paper by Drs. di Guilio and Ballini (given on Thursday morning) are mainly concerned with examining a range of sulphur, peroxide and sulphur-modified peroxide cures, though the former authors cast around a little more widely for possible curing agents. The problem of a curing system for these polymers is not solved. Copolymers with vinylacetate seem to be regarded as a substitute for, or possibly an improvement on, thermoplastic polyethylene, though to obtain higher softening points some crosslinking by peroxide or radiation is necessary, and, moreover, this is best achieved in the presence of a multifunctional transfer agent. Vinylacetate as a co-monomer has the advantage of improving the adhesion and the clarity of polyethylene as well as giving a polymer with easier processing characteristics which arise, of course, from its lower softening point.

Elastomers were again discussed in the conference room on Thursday afternoon when three papers dealing with analysis were presented. Drs. Kimmer and Schmalz deal with the determination of isomers present in polymers. This is a very full paper with considerably more discussion and detail than usually gets past the referees of the journals and, for this reason alone, will be a valuable source paper for students. Too frequently it is taken for granted that 1,2 and 1,4 addition are "determined from i.r. spectroscopy"

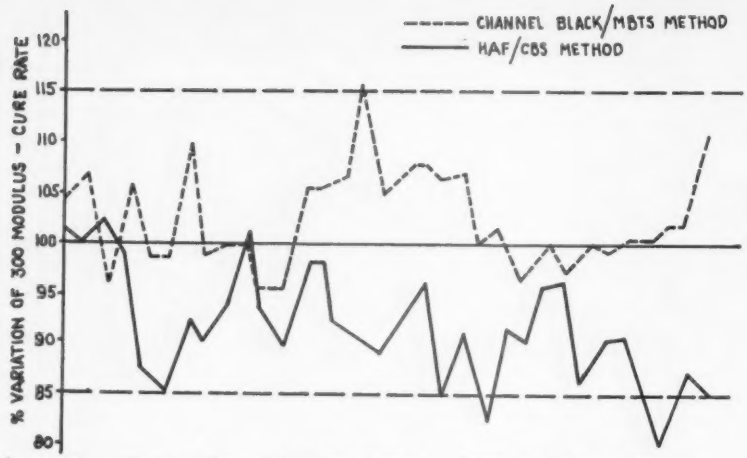

Figure 2—Cure Rate of Incoming Deliveries of SBR 1500 Over a Three Month Period.

without thought of the principles involved or the accuracy possible. The authors place greater reliance than the reviewer does on iodine values for unsaturation determination. In an unknown polymer—and one in which the isomers are required is by definition an unknown polymer — the possible effects of cyclization, splitting out, and so forth, can obscure the quantitative addition reaction. It is good to see the determination of the extinction coefficients fully discussed and the extrapolation that this involves.

Dr. Feuerberg presented a paper on identification and quantitative determination of elastomers in rubber which this reviewer was particularly interested in hearing, having already given some thought to this subject, and Dr. Brodsky presented a paper on the determination of residual monomers in latices. This, too, is of interest in view of the current desire to write such determinations into British Standards for SBR. The method developed is gas chromatography at 80° C. with hydrogen as the carrier gas, dimethylglycolphthalate as the stationary phase on kieselguhr. High temperatures, 200° C. and over, are used for injection which is by syringe through a rubber vaccine-type cap. The method is said to give a result in 8 minutes and to measure concentrations of monomer down to 0.02 per cent with an accuracy of 5 per cent.

Capillary Flow Method

The last paper to be mentioned from this group was somewhat on its own and dealt with a capillary flow method for assessing processing behavior. Effectively, this method is a capillary extrusion plastimeter which provides two parameters describing the behavior of the polymer instead of the one given by a Mooney viscometer, as normally used. Derivation of the parameters depends on a double-log plot. The English title announced in advance was a little misleading for, in spite of their obvious and institutional interest in neoprene, the authors do, in fact, discuss other polymers. It is a paper for rheologists.

The third group of papers on elastomers was presented on Friday afternoon in the conference room and dealt with raw rubber. Drs. Soininen, Bask and Pehu-Lehtonen present evidence based on the effect of piperidine on rubber solutions, showing that some association between natural rubber molecules is sufficiently stable to withstand processing and is not dissociated by ordinary polar reagents which would disrupt certain types of hydrogen bond. They ascribe the effect to carboxylic acid groups present in natural rubber but absent from synthetic *cis*-polyisoprene. It is a pity they did not fractionate their rubber samples and demonstrate its presence in the more heavily oxygenated fraction.

Dr. Peakman discussed what in the now permissible short Anglo-Saxon words is *dirt* in rubber, referring to it politely as *foreign matter*. He makes in his paper the fairly obvious point that it is mesh opening, not mesh size, of a screen that is important, but he also includes a lot of factual data of interest to compounders and a short discussion about the probability of particles of dirt being so located as to be a major cause of tread cracking. There is, apparently, not a great deal to be said for this ancient belief. With the advent of synthetic general purpose rubber, dirt ceases to be a problem and variability in supplies a thing of the past—or so we were led to hope. Dr. Heal discussed the standard SBR rubber LTP 1500 made to specification by four suppliers. This paper is frankly polemical with two major accusations: (a) synthetic rubber is a very variable product; and (b) some of the lack of control by the producer is due to his use of an out-of-date test compound using EPC black and MBTS acceleration. I think he firmly establishes his case and, for good weight, some other points are thrown in and may be conceded; principally that it is the rate of cure of SBR 1500 which is variable, and the processibility of the oil-extended version, the former being illustrated by Figure 2 and the latter by Figure 3. However, evidence of completely sound statistical planning of the experiments is missing, and consequently there is room for procedural or testing differences to be invoked to cover some of the change. For instance, there is a clear trend in Figure 2. How real is it?

Man-Made Fibres

We turn now to the second main topic of the conference and to the series of papers which opened in the conference room on Wednesday after the plenary session in the auditorium. All seven papers mention tire cord in their titles and we may properly include the paper on cord paths in tires given by Dr. Gough on Thursday morning. Three papers discuss the textile for tire cord, and the two American papers, one dealing with the newer viscose cords and the other with nylon, will not be discussed here. Dr. Titzmann's account was of the properties of polyester-cords compared with other textiles, and gives the German view. Moreover, the range of comparison is wide and, apart from rayon manufacture which has been discontinued at Bobingen, the author seems equally interested production-wise in Nylon 6 and 66, polyester (polyethylene terephthalate) and polyvinyl alcohol, and this reviewer presumes materials quoted are all of German manufacture. In so far as the values can be read from a rather small diagram, the tenacities at

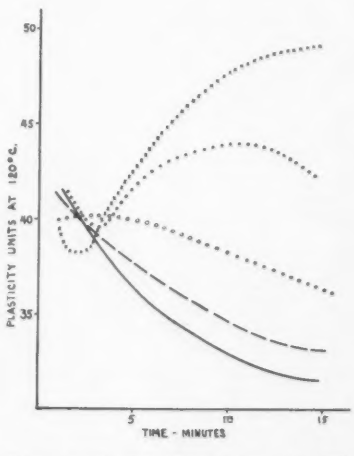

Figure 3—Plasticity-Time Curves for Different Samples of Oil-Extended Rubber.

room temperature and 100° C. are given in Table 2, determined on a Zwick machine, distance between jaws 50 cm, time of loading to 1 g/den. approximately 3 sec. The 100° C. values were measured after 3 min. controlled immersion in paraffin and the shrinkage measured during immersion in paraffin. Table 2 sets out the static properties of the materials Dr. Titzmann discusses, and two questions immediately come to mind: Why is the super-super rayon so low and why is the shrinkage of the tire cord polyester omitted?

Properties over the range 20 to 200° C. are given in diagrams for all the materials and after very brief comment on them the paper turns to a discussion of the thermal degradation of cord materials. The cords were placed tensionless in strand form in atmospheres of pure nitrogen, steam, and air at a series of elevated temperatures from 120° to 210° C. The results are expressed as per cent of remaining tensile strength and were shown over a number of diagrams, first as a function of time at 210° C. and then as a function of temperature after eight hour exposure. Purely thermal degradation, presumably in the absence of stabilizers, can be ignored below 150° C. but at 210° C. the polyesters break down at first and then the breakdown appears to be self-inhibiting. Nylon 66 similarly shows a retardation but the initial rate is lower and the retardation starts much later. The rayons show greater degradation and nylon 6 the greatest. In air, oxidation takes control and the polyesters show to greater advantage while in steam the improved nylon 66 is the best, ordinary nylon comparing with the improved rayons. This general picture is well-known, but it is useful to have it factually before one; it can be modified by the incorporation of antioxidants and other stabilizers against thermal degradation but not against hydrolysis.

Table 2—Tenacities and Shrinkage of Tire Cord Materials (100%)

Textile and denier	*Tenacity in g/den*		*Shrinkage at 160° C*
	RT	*100° C*	*%*
Improved nylon 840/140 (high shrinking)	8.3	6.0	6.0
Polyester 1000/200	8.0	5.3	10.0
Nylon 6 840/140	7.8	6.0	6.8
Polyester (low shrinking) 1050/200	7.5	5.3	3.2
Normal nylon 66 840/140	7.4	5.3	6.2
Polyester (tire cord type) 1070/200	7.0	5.1	not given
Polyvinyl alcohol 1210	5.8	5.0	extends ca 1%
Rayon (super-super) 1670/720	5.1	3.9	2.0
Rayon (super) 1630/720	3.9	3.2	1.9
Rayon (normal) 1690/720	3.6	2.9	1.8

Creep and Growth

There is no subject connected with tire cord which has caused more trouble than the lack of dimensional stability shown by nylon and polyester. This has led to the need for hot stretching and post-inflation which, incidentally, are very fully discussed by Dr. Lauterbach for nylon. Dr. Titzmann presents comparative data on the phenomena concerned by ranking the materials in order of their per cent elongation at 1 g/den on loading and unloading after a period of 13 days and giving the percentage increase in elongation for 20 days relative to five hours. The essentials of his tables are given as Table 3.

Obviously the materials rank differently for each column of data and the tire designer can take his choice and having made it, adapt his design to take advantage of, or minimize, the effect of the particular combination of properties his choice has given him.

Of course, all the above discussion assumes a battery of meaningful tests with an adequate background of interpretation, and some of the other papers concern themselves with just this point. Most of our testing is so-called static testing and results may or may not rank materials in the same way as dynamic tests. In any case, it may be argued that tests on cords differ from the actual system existing in a tire and thus lead to the desire for measurements made on the cord embedded in rubber, and to evaluation of the adhesion between cord and rubber. Drs. Kemnitz and Espanion discuss the effect of cord construction, mainly twist, on a variety of static properties and then consider a number of dynamic tests, again with some emphasis on twist. They conclude with some correlation diagrams relating to (a) compression fatigue to loss in twist; (b) dynamic modulus to cord retraction; (c) damping of elongation and ratio of elastic strain to total strain; (d) loss in twist to tan δ of material; (e) energy damping to cord retraction; (f) loss energy to cord retraction. The frequency of the dynamic tests was 17 CPS and the material, rayon.

One of the two papers from eastern Europe was presented by Dr. Bartha of the state research institute for rubber in Budapest. The author has evolved a method for the dynamic testing of tire cord which bears strong resemblance to the well-known Goodyear tube test in which a tube construction is rapidly flexed by rotating it while it is bent through an arc of 90°, the time to failure assessing the merit. The Hungarian test uses a solid cylinder of rubber instead of a tube; on the outside of the cylinder the cords are bonded in the surface parallel to its axis. It is claimed that failure of individual cords can easily be seen and that cords can be extracted and examined after a period of fatigue. Simple elasticity theory gives approximate values for the average tensile force ($\overline{P}$) and maximum strain of the cords which will be alternately extension and compression (e). The lifetime of the cord will then follow an equation:

$$\log n = \frac{D}{e+m}\left(1 - \frac{P}{Po}\right) \text{ where}$$

Table 3—Elongation on Long-Term Loading and Unloading (Room Temperature)

Material	*Elongation at 1 g/den. Per cent absolute*	*Elongation Retained after unloading Per cent relative*	*Growth 20 days/5 hrs.*
High shrinkage polyester	1.9	15.8	18.8
Tire cord polyester	2.1	21.4	18.9
Low shrinkage polyester	2.15	27.9	15.8
Polyvinyl alcohol	2.6	34.6	30.0
Super-super rayon	2.8	39.3	16.7
Super rayon	3.5	40.0	10.0
Standard rayon	4.15	47.0	23.6
Standard nylon 66	4.6	15.2	5.7
Nylon 6	4.75	11.6	5.5
Improved nylon 66	5.1	16.7	6.2

n is the number of cycles and D and m are parameters to be determined. The results suggest that this analysis has some validity which, if substantiated, means that it might be preferable to the purely empirical rotating tube test, for it is a simpler test piece to make and does not involve, as does the other, reinforcing textiles not part of those actually being tested. Dr. van Wijngdaarden of Holland gave the details of his improvements in making and using the Firestone flex fatigue test sample. The amount of detail he gives concerning the building of the test piece, the need to measure and correct for twist variation and his emphasis on the need to design the experiment statistically are all admirable. What he does not give, however, is a worked example with the analysis of variance corresponding to his balanced incomplete block. What sort of residual error is obtained? How large does the experiment need to be to achieve given levels of differentiation? Here some actual figures would be of inestimable benefit.

Still dealing with tire cord, the gadgeteers will wish to notice a device for the rapid determination of moisture in cords described by Drs. Haase-Deyerling and Meumann. It is a black box into which the cord is fed into two measuring slits. The authors show its use in maintaining control charts as, for example, when material comes from the calender.

Tires Discussed

In transferring the discussion from the cord to the tire we can consider in passing Dr. Gough's paper on cord paths in tires. Published work undoubtedly lags well behind practice in this field and Dr. Gough introduces methods which he has been using for some years. His paper is necessarily complex and will be read in detail only by specialists. His work starts from the premises that cord paths, and therefore other dimensions of a tire, cannot be described by closed mathematical functions. He finds, however, that if the radius from a given point on a tire section to the axis of rotation is plotted against the cosine of the cord bias angle, a diagram is obtained which describes the cord path and enables deviations from simple trellising to be used for prediction and correction of design. The R-cos ø chart can show the behavior of the assembly during shaping, and slippage, if any, can be detected; and can be used as the basis for determining the cord path in the tire from that on the former on which it is built. The steps in calculating on a digital computer are given for cord path calculation from given R-cos ø curves. The usefulness of this paper will depend on the extent to which it is in advance of, or at any rate differs from, methods in use in other design offices.

Table 4—Diffusion Constant as a Function of Temperature and Black Content (D x 10^7 cm^2. sec^{-1})

	Loading of HAF Black			
Temperature	*10*	*20*	*30*	
40°C	2.82	2.63	1.83	...
80	6.75	5.38	4.17	1.97
120	13.40	10.13	6.10	2.77

Tires were discussed in the auditorium on Thursday afternoon and one of the papers we have already reviewed was presented. It is paralleled by the paper of Drs. Kern, Hafner and Nippold in that these authors too are concerned with geometrical descriptions, but of the finished tire and not merely the cord structure. As with Dr. Gough's paper, Dr. Kern and his colleagues have written for the specialist. They consider in detail the stress and strain trajectories on that portion of the tire carcass behind the tread which is in contact with the road and consequently deformed. These trajectories are computed electronically from measurements made on the tire. Once again, their value can only be assessed in the tire design offices of other manufacturers.

The outraged squeal of a misused tire I have always taken as a reproach for cornering too fast. It contributes to road safety and it might be held anti-social to design tires that don't squeal when misused. Drs. Miller and Slaby do not share my backward opinions and their paper analyzes the phenomena. A paper by Dr. Cooper analyzes the stiffness of a tire into two components, one due to structure and the other a pneumatic component "carried by the air pressure acting on the contact patch." Treated empirically this is fair enough and enables useful design data to be obtained rapidly with simple mathematics.

Elastomers and Fibres

It is undoubtedly true that the papers so far reviewed were those around which the conference was built and constituted for many German technologists the meat of the conference. This was clearly shown by the attendances at the sessions and the discussions outside them. The organizers, in concentrating on elastomers and fibres, had drawn attention to the joint use of these materials in bulk in our automotive society. Something of the competition of nylon with the newer rayons was shown at the conference, and the competition between natural rubber-polybutadiene blends and SBR to provide the treads was also shown. But it is high time we turned to chemistry for a change.

Professor Scheele opened the Thursday morning auditorium session devoted to *Vulcanization*. His review of peroxide and sulphur vulcanization of synthetic rubbers was stimulating if sometimes speculative. One of the advantages of speculation is that it may serve to encourage discussion, and in this case it did. Scheele was followed by Dr. Kern presenting a paper jointly with Drs. Franck and Hafner on the activation energy of vulcanization. In the work described the authors argue that the time to achieve a given level of modulus, tensile strength or free sulphur may be taken as equivalent to a rate constant and, from the usual Arrhenius equation, the plot of the log (time) against reciprocal temperature, one can obtain an activation energy.

Physical Chemistry

The authors find that straight lines of the same slope (meaning equal activation energy) are obtained with all three of the properties mentioned above using, of course, the same compound (accelerated by cyclohexylbenzthiazylsulphenamide). Under normal factory conditions the process is not isothermal, for vulcanization starts as the compound warms up and continues as it cools down. Calculations, with a computer, enable an equivalent temperature to be ascertained and properties calculated for this temperature agree remarkably well with those found. However, one is instinctively cautious in discussing the over-all energy of activation of a complex process which must include a number of steps. For one thing the argument can only apply to properties as they increase up to the optimum cure judged on modulus and tensile strength, and in fact some extrapolation is involved. Is the close agreement in the Arrhenius plots between the physical properties and the consumption of sulphur other than chance? What happens, for example, if the compound is modified or a different accelerator system used? One has the feeling that the Arrhenius plots would depart from linearity and with this departure what theoretical basis would remain?

Dr. Studebaker continues his use of lithium aluminum hydride as a tool to investigate the cross-linking of rubber, this time in MBT accelerated stocks. His work will be well-known in America. The German papers in this section include a paper by Drs. Auler and Boström on the diffusion of S_{35} in rubber. This technique has (Auerbach and Gehman) been used before.

The authors are, however, particularly concerned with diffusion in the presence of carbon black. By plotting the log concentration against the square of the distance a linear plot is obtained if Fick's law holds, which is true at the concentrations considered.

Diffusion Constant

Drs. Auler and Boström conveniently summarize their figures for the diffusion constant as shown in Table 4.

It will be noticed that the diffusion constant depends linearly on the black content. Some experimental work on the diffusion of sulphur from the breaker-strip to the side walls of a giant tire cover substantiated the calculations made from the more fundamental measurements. The authors point out that variation in the filler loading enables the diffusion rate to be held at a desired value. Another German paper by Drs. Mocker and Old reviews the possible uses of the polarograph in the rubber laboratory. This paper is longer and more detailed than those most English/American journals publish, especially in its exposition of the basis of the subject. As regards analytical estimations, it treats of ZnO in technical zinc oxide powder as well as its lead and cadmium content; zinc sulphide and oxide in "Sachtolith" and lithopone; zinc covering on galvanized iron (this seems *de trop*); zinc oxide in vulcanizates (by first ashing); similarly, lead in vulcanizates and in litharge. Combined sulphur is dealt with by wet oxidation to sulphate which is determined indirectly by lead precipitation, and free sulphur by pyridine extraction and direct polarography after removal of oxygen. The methylene blue absorption onto blacks and other fillers was also studied and a range of figures is reported. The second part of the paper deals with organic groupings common in accelerators and other substances, and in particular with MBT and MBTS and their transformation rate. If I may presume to offer criticism in my comment on this paper I would say that too much has been attempted by reviewing and working over the whole field in one paper. The free sulphur determination is given without any indication of interference from antioxidants or accelerators. Only certain unusual compounds do interfere but they are in the literature. Similarly, ashing is a crude method of obtaining organic free material with Zn, Cd and Pb present and cannot be applied to neoprenes. On the other hand the exploration of polarographic technique has shown its possibilities more widely than hitherto and warrants a series of more critical papers or even a monograph from the authors.

Every conference attracts its quota of papers on physical testing and over the years we can see the trend towards dynamic rather than static tests, ever fresh attempts at an abrasion test that will simulate tire tread behavior and an expansion at both ends of the temperature range. Thursday morning in the conference room was devoted to this subject with seven papers and two more were presented on Friday afternoon. They may be considered in two sections, the first dealing with specific known test procedures, and the second with properties and principles. In view of the need to keep this review to a reasonable compass I shall deal with the second of these sections noting only the titles of the papers relevant to the first so that those concerned with this subject matter may refer to the full papers in *Kautschuk U. Gummi* as they appear. As they will be printed in the language in which they were written, I note it for the information of monoglot readers: "New Abrasion Studies on the Dunlop-Lambourn Principle" (in German) Dr. D. Beckmann; "Cold Testing Methods for High Polymers" (in German) Dr. O. Umminger. (This paper lists 19 methods of test, 11 of them in various national standards (including one from the U.S.S.R.); "International Rubber Hardness, Microhardness and Shore-hardness" (in German) Drs. F. Händler and P. Kainradl; "Influence of the Thickness of Test Vulcanizates on the Tensile Strength Values Measured by the ASTM Standard Method" (in English) Dr. D. I. Nazeni; "Tensile Strength of SBR Vulcanizates, Reliability and Methods of Measurement" (in English) Dr. W. May.

Table 5—Structure and Vulcanizate Properties of Silicas

Material	*Water lost above 120°*	*Surface Area BET*	*Carman**	*pH*	*Foreign Oxide %*	*Tensile Strength kg. om⁻²*	*Shore Hardness*
		m^2g^{-1}					
Highly active silica	9	155	83	6.8	1.0	210	80
Half-activated silica (about equivalent to a china clay)	12	18	13	7.2	7.8	200	68
Highly active silica (unheated)	Not Given	130	70	7.1	1.1	220	80
Same silica (heated to 400°C).	2	110	65	—	—	235	79
Same silica (heated to 600°C)	0.4	40	30	—	—	200	80

*A gas permeability method

Physical Testing

It is pleasing to record that the first two papers dealing with principles and properties reported collaboration between research groups in Germany and in England. This is a development which should not go unnoticed in America.

The main point of these papers, as I understand them, is to suggest a temperature—frequency transform for dynamic properties (*e.g.* the dynamic modulus) other than that used by Dr. Ferry and his co-workers and which is, moreover, independent of the glass-transition temperature. If accepted, this is of course very important. The further part of the work concerns the effect on the dynamic modulus of the cross-link density and the carbon black structure. The approach of Dr. Bulgin and his co-workers is to obtain a relationship between frequency and temperature for equal values of the property considered, modulus or resilience.

Dynamic Properties

Since this relation shows as a linear one when log (frequency) is plotted against I/T, they suggest that the process is reasonably represented by an Arrhenius' type equation from which activation energy and frequency factor can be calculated. The energy found is the same for both resilience and modulus and is largely independent of their magnitude. The frequency factor is, however, sensitive to these properties. It should be added that the supporting data are taken from experiments with seven types of dynamic tests which jointly cover a frequency range from 0.1 to 20,000 cps. The effect of cross-link density is discussed in general terms without reference to the transform, and the amplitude effect when carbon black is present is also confirmed down to the plateau region at very small amplitudes. The modulus of loaded stocks at these very small amplitudes is found to be a function of the surface area of the black incorporated. These two papers need critical appraisal by specialists and I hope early publication will bring in its train the analysis that the carefully accumulated data obviously require.

The Leverkusen laboratories have been pioneers in the appreciation of the need for dynamic testing and also in providing the means for realizing practicable tests. Drs. Clamroth, Ecker and Fromandi continue in the tradition with a paper which commences by

reviewing visco-elastic properties and by referring to the new version of the Roelig machine, details of which are now available (*Kautschuk U. Gummi*, August 1960). The new machine has a positive cam action drive giving known synusoidal strain and by an ingenious mechanical device enables the hysteresis ellipse displayed by optical means to be closed to a line by movement of the mirror and hence the phase angle to be read directly. The thing that appeals is the absence of electronics; it is a simple mechanical device. The authors discuss the dependence of the dynamic modulus on the amplitude for strains from 0.01 to 0.5, *i.e.* 10 per cent compression and greater, and then turn to the subject of fatigue testing by biaxial stressing.

A New Test

This new test is described and the influence of various sample parameters discussed in detail. For example, the direction of calendering the sheet from which the sample is taken is considered, as well as the more usual factors of thickness, time and temperature of cure, and so on. Effectively, the instrument measures the resistance of the sample to crack growth. This is referred to as the intrinsic strength of the material (Strukturfestigkeit) and the evaluation of this parameter in terms of mean strain, amplitude, crack length, frequency, sample thickness, etc., forms a major part of the paper. The significance of these various conditions has been assessed by regression analysis made feasible for the vast amount of data by electronic computation. Polynomials of second degree were computed and tested, and it is shown that the need for the introduction of the squared term varies with the compound considered. The final results are presented as three-dimensional diagrams. The last new test method, considered by Drs. Clamroth, Ecker and Fromandi, is an abrasion test based on the now familiar Lambourn principles. Both machine and results are discussed.

Dr. Backes is also concerned with dynamic properties measured by the Roelig machine. The principle parameter evaluated is the dynamic stiffness which is investigated as a function of temperature, carbon black or zinc oxide content, and softener. Like Dr. Bulgin *et al*, he uses an Arrhenius type equation to express the temperature dependence of the relaxation times calculated from the damping coefficients. Three-dimensional diagrams complete the presentation by showing the difference in properties from those of the unloaded polymers as functions of temperature and loading of filler or softener.

The program of the conference modestly gave the auditorium over on Friday morning to *Fillers and Vulcanization II* and I will only mention the two papers accounting for the second part of the title. These both referred to the use of phenolformaldehyde resins as curing agents, one by Mme. Thelomon from France and the other by Dr. Giller from Germany. The papers on fillers are more ambitious than the sessional title would indicate.

Fillers and Reinforcement

It is well known that black mixed into latex and then dried out does not reinforce the rubber unless at some stage of its processing it is passed through a mill to produce the necessary free radicals by mechanical rupture of the rubber molecules. M. and Mme. Lamm examined this system with the help of radiation and found, as they had expected, that irradiation could take the place of mastication in producing the necessary radicals. Unexpectedly they found that if the black and the latex were separately irradiated and then mixed, *better* reinforcement was obtained for the same radiation dose and, moreover, if a period of heating was added after the mixing, still higher tensile strength *and* higher elongation at break were obtained. Their experiments were limited to the determination of mechanical properties and no cross-linking indices were obtained by swelling data. However, as they state at the end of their brief communication, here is an entirely new field waiting for further exploitation. Measurement of cross-linking and apparent cross-linking by swelling in solvent is the obvious next step.

Dr. Albrecht's paper showed the properties in a test mix of a number of prepared silica fillers together with their structure. His findings are given in abbreviated form in Table 5.

It will be noticed that the technological properties of the highly active silica have been hardly affected by heating though it is apparent that the structure has undergone a vast change. Electromicrographs show that some sintering together of particles has occurred with the material heated at 600° C. and it is surprising that this has not modified the technological properties more, though the fuller table given by Dr. Albrecht does show greater modification than is indicated above.

Carbon Structure

Dr. Schweitzer deals with carbon structure and its effects on the usual range of tensile properties. The treatment is very detailed and includes data on "post-treated" black, devolatization and detritioning but the content of the paper is presumably known, or easily available, in America. Dr. Bernemann gives the Hüls experience of rubber/carbon black wet masterbatching. The advantages of this procedure have been well canvassed in America and German experience seems unexceptional.

Three of the five papers devoted to aging and presented in the auditorium on Friday morning were given in English and reviewed, in an interesting way, in a recent work which is available, or shortly will be, in other publications elsewhere. Of the two papers in German, one was actually from Canada but given in German, a courtesy which I am sure was appreciated by our hosts.

Dr. Edwards studied a series of butyl compounds vulcanized by a sulphur system, quinone, or resin, and aged them at elevated temperatures in air, in superheated water in the absence of air and also in its presence. In addition to some of the usual physical measurements, the author assessed the build-up and breakdown of the cross-linked network of molecules by means of solubility and swelling measurements. The relation between cross-link density and time of heating shows, at least with sulphur vulcanizates, a rise (unless the curing time has been very long) followed by a rapid fall which later flattens out. Dr. Edwards takes the central portion of these curves and shows that the reciprocal of the network density plots linearly against the time of heating, thus enabling a reaction velocity constant (second order) to be obtained which varies with the degree of unsaturation of the original polymer, decreasing with increasing unsaturation.

The Quinone System

The quinone system behaves similarly but the resin-cured vulcanizates are not sensitive to the degree of unsaturation. The type of scission during aging was also investigated, and a plot of the amount of soluble matters as a function of the ratio of cross-link densities before and after aging shows that the quinone and resin cured vulcanizates break down by chain scission, whereas some of the total scission occurs at the cross-links of a sulphur vulcanizate. One of the physical properties measured is the modulus after being held at 50 per cent extension for one minute. This is found to be linearly related to the cross-link density. Other properties investigated include water absorption and surface softening, the latter for resin cured rubbers only. In many ways this paper is a model of what a modern technological paper should contain. Familiar mechanical properties are not neglected, but they take second place to measurements which really tell us what is happening to the cross-linked structure which vulcanization gives us, where scission occurs and under what conditions. The physical properties depend on these changes and, by medical analogy, are the symptoms of which the network structural changes are the cause.

Drs. Kempermann and Clamroth report a fairly exhaustive search for effective anti-ozonants for oil-extended SBR. Both accelerated and open-air tests

were used, the former over a range of ozone concentration from 12.5 to 400 ppm. Measurements consisted of observing the induction period for the start of visually observed cracking and the rate of increase in the numbers of cracks. Both these procedures are open to criticisms of which the authors show themselves to be fully aware. They find that the same relationships between various chemicals hold for oil-extended SBR as hold for natural rubber and unextended SBR. They feel that the two parameter approach (induction period and rate of growth) is valuable, and that derivatives of p-phenylene diamine are superior to other chemicals tried. Dynamic tests can, of course, give a different picture and this was not investigated so thoroughly, but there seems little doubt that reagents superior statically are also good dynamically.

A Morphological Study

I have left till last the paper by Prof. Schoon, a morphological study given on the first day of the conference, partly because it does not fit easily under the other headings, but also because of its unusual interest. Prof. Schoon has taken a number of polymers, cast films from solution in benzene, shadowed these films by evaporating iridium onto them, and then backed the iridium with silica before destroying the original polymer. These replicas were examined by electron microscopy. The original polymer films were usually about 100 micron thick. The magnification was 20 to 80,000 followed by further enlargement of the negative of the image.

Prof. Schoon interprets the pictures he gets as showing that polymer films cast from solution do not dry down to a felt-like structure of interlacing molecules, but each molecule forms a ball contacting, but not entangled with, its neighbors. The surface of the replica shows these spherical forms and their size can be measured. From the apparent diameter Ostwald long ago provided a table converting the measurement into molecular weight for given densities and this enables Dr. Schoon to give molecular weight distributions from a measurement of the particle sizes shown in the electronmicrographs. Several such distributions are given in his paper. Both synthetic and natural rubber show this packing of spherical macromolecules, the synthetics being, in general, smaller particles than the natural product. The paper is a very short one but its importance is not to be judged from the length. Figure 4 shows the excellent differentiation of detail which the technique has achieved. One would, of course, like to see some conventional molecular weight determinations made on the same materials. From the frequency distributions which the author gives, it is easy to estimate values for

Figure 4—Surface of a natural rubber latex, the replica obliquely shadowed with silica, magnification 60,000.

$(\overline{M}_w/\overline{M}_n)$ and if these could have been compared with those found from conventional measurements, the story would have been complete. However, even without this rebutting evidence it seems that we have to revise our ideas of the physical constitution of solid polymers that have not been sheared by milling. We have also an independent method of measuring molecular weight, and a new conception of what a polymer surface looks like on the molecular scale. Quite a fair cull from a paper which, excluding tables and diagrams, is only three and one-half pages long!

Conclusion

From a conference of 63 papers I have chosen to deal with those directly concerned with the two main themes, papers dealing with technology and the principles of testing, together with a few of personal interest. An apology is perhaps due to those authors whose papers have been passed over. No reflection on their content is intended; indeed, in some cases quite the reverse for I am assuming the authors or their work to be sufficiently known in America and I have deliberately emphasized the German contribution. It is fairly clear that the pattern of textile development for tires is not the same in Germany as it is in the United States; also, with the smaller market and the lack of an indigenous oil producing industry, fewer types of synthetic rubber are likely to be produced and possibly, therefore, there is a slower rate of development in the use of newer types. However, this may not be true for EP rubber on which there is some concentration of effort. Our hosts seemed to be particularly gratified that the international attendance was so high and the personal interchange of comment and opinion outside the auditorium and conference room undoubtedly cut across the national boundaries, thanks largely to the fluent English spoken by such a very large proportion of the German professional classes. The closing session held in the auditorium was only a brief thank you to the organizers and a statement that the next DKG international Kautschuk-Tagung would not be held for three or four years. The organizers are wise in isolating their success by a longer period than in the past, for other conferences loom ahead and too many can easily defeat the object of holding them at all. In any case we must await the fullness of time to see what develops from what the Berliners call *die schwangere Auster* for undoubtedly new ideas will appear on both sides of the Atlantic as a result of the exchanges which occurred under its roof.

Finally, may I mention the universal praise from all nationalities for the imaginative design of the Kongresshalle and its amenities? In spite of the irreverence of its nickname, Berliners are obviously proud of their building; and rightly so for it is an architectural masterpiece — for which they are indebted to you.

Polybutadiene Tires

► U. S. Rubber Co., New York, N. Y., has begun production of truck tires with treads containing a blend of polybutadiene synthetic rubber and natural rubber, in the first commercial use of polybutadiene. Last March the company started using polyisoprene in truck tires. According to the company, the polybutadiene tire runs from 15 to 20 degrees cooler, and it gives approximately one-third more mileage than truck tires with all natural rubber or polyisoprene treads, and is resistant to groove-cracking. The tire is available in 8.25/20 and 9.00/20 of the U. S. Royal Fleet Carrier truck tire, produced in tubed form in both rayon and nylon cord construction. U. S. Rubber has also announced that it is developing tires made entirely of polybutadiene which are being evaluated for possible future adoption as production of the new material is stepped up.

RABRM Changes Names

► The Research Association of British Rubber Manufacturers (RABRM) has changed its name to Rubber and Plastics Research Association of Great Britain. Research will be done at the testing laboratories of RABRM at Shawbury, Shropshire, where work on an extensive plan of new buildings is underway. Plastic manufacturers, who are members of the British Plastics Federation, are to be represented in the association by a Plastics Research Committee and by representatives on the council.

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Names in the News

Peter J. O'Reilly, formerly with Roger Williams Technical and Economic Services, has joined the Product Development Department of the Harchem Division of Wallace & Tiernan, Inc., Belleville, N. J. **Donald Wild,** formerly with Chemical Rubber Co., has joined Harchem's field sales staff in the Midwest area.

Frederick W. Moyer, who has been assistant treasurer of B. F. Goodrich Co., Akron, Ohio, has been elected treasurer of the company. He succeeds **E. A. Stevens,** who has retired for reasons of health.

Hamilton M. Ross has been elected a vice-president of Hewitt - Robins, Inc., Stamford, Conn. **Norman M. Godfrey** will succeed Mr. Ross as manager of the Robins Conveyors Division, Passaic, N. J. **Martin Vander Laan** has been appointed director of engineering sales.

Eleanor Crouse, formerly research librarian for Columbia - Southern Chemical Corp., Barberton, Ohio, has joined the staff of the Institute for Advancement of Medical Communication, New York, N. Y., as research associate and librarian.

Prof. Giulio Natta, pioneer in the field of stereospecific catalysis and stereoregular polymers, has been awarded a gold medal and honor citation by the city of Milan, Italy.

Ken C. Tucker, formerly manager of the Food Industries Division of Oakite Products, Inc., New York, N. Y., has been named assistant sales manager of the firm.

A. Campbell, Jr., has been promoted to manager of sales and marketing services for the Thermoid Division of H. K. Porter Co., Inc., Pittsburgh, Penna.

Bryce I. MacDonald, Jr., has been named manager of manufacturing engineering at the Silicone Products Department of General Electric Co., Waterford, N. Y. He succeeds **Dr. E. M. Koeritz** who recently was named manager of manufacturing at the Metallurgical Products Department of G-E in Detroit, Mich.

William R. Randle, previously assistant purchasing manager for Industrial Rayon Corp., Cleveland, Ohio, has been named purchasing manager, succeeding **George F. Courson,** who has retired after 25 years of service.

William J. Hanley, president and owner of Custom Engineering Co., Erie, Penna., will go to England to discuss the establishment of an English subsidiary.

R. Bruce Baptie has been appointed to the position of products manager, industrial chemicals, and **Charles F. Blaich, Jr.,** to the post of sales development supervisor, at the Carwin Co., North Haven, Conn.

Francis Cameron has been elected president of the St. Joseph Lead Co., New York, N. Y., succeeding **Andrew Fletcher** who has been elected board chairman, and **Robert H. Ramsey** and **Lawrason Riggs 3d** have been named vice-presidents.

George F. Polzer has been promoted to the post of vice-president in charge of purchasing, transportation and customer relations for Witco Chemical Co., Inc., New York, N. Y., and will direct these activities for all Witco divisions.

Douglas Mueller, assistant to the president of Seiberling Rubber Co., Akron, Ohio, has been named director of merchandising and public relations and will supervise the company's advertising, sales promotion and public relations activities.

I. Rogosin, chairman of the board of directors for Tyrex, Inc., New York, N. Y., will become president of the organization, effective January 1, as **William Dalton** has resigned the post; **Philip E. Robinson** has been appointed secretary-manager.

Richard L. Moody, a sales engineer for the company since 1958, has been named assistant sales manager for Wilson Rubber Co., Canton, Ohio, and will work directly with the company's sales engineers and wholesale distributors.

Robert F. Shreve

Appointed by Spencer

► Robert F. Shreve has been appointed head of the Research and Development Department of Spencer Products Co., Ridgewood, N. J. A graduate of Carnegie Institute of Technology, Mr. Shreve previously was associated with American Viscose Corp., and General Mills. While at General Mills, he was in charge of process development in the Central Research Laboratories. According to Spencer Products, Mr. Shreve's appointment coincides with the firm's program for the development of new products for the rubber and plastics industries. Spencer Products now produces Ridacto, an accelerator activator.

Mahoney Named President

► J. D. Mahoney has been elected president of Mobay Chemical Co., Pittsburgh, Penna., succeeding J. R. Eck, who has rejoined Monsanto Chemical Co. as assistant general manager of its Plastics Division. Mr. Eck has been president and chairman of the board of directors of Mobay since March, 1958. Mr. Mahoney is a graduate of the University of Illinois with a B.S. degree in chemistry. He was a member of Mobay's original executive staff and has been director of marketing since the firm was formed in 1954 as a jointly-owned associate company of Monsanto and Farbenfabriken-Bayer A.-G.

► Bulletins BL-357, BL-358, and BL-362, respectively entitled "Continuous Vulcanization of Neoprene Extrusions in Liquid Curing Media," "Use of Sulfur to Increase Tensile Strength of Neoprene Type WB," and "Oil Extension of Neoprene Latex," are offered by the Elastomer Chemicals Department of E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.

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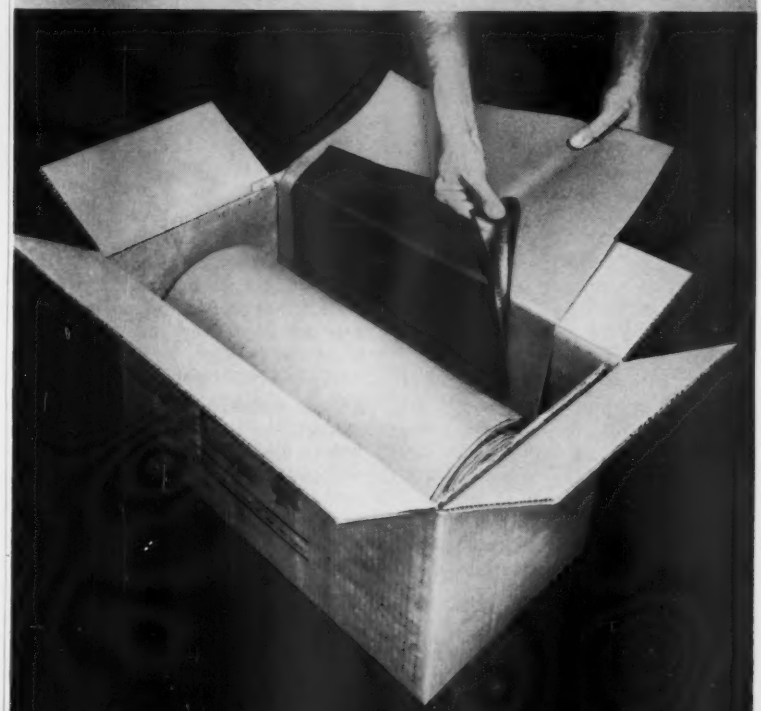

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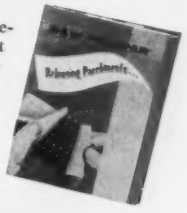

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Financial News

Columbian Carbon

► Nine months ended Sept. 30: Net earnings for the period rose to $5,344,000, or $3.31 per share, from $5,226,000, or $3.24 per share for the similar period in 1959. Consolidated sales increased 10 per cent to $60,895,000 from the $55,264,000 volume in the 1959 period. The record sales and earnings were in spite of a comparatively unfavorable third quarter. Although the quarter sales of $19,540,000 were 4.8 per cent ahead of the $18,646,000 volume for the same period of 1959, net earnings declined by 24.3 per cent. According to the company, increases in write-offs for dry holes, geophysical expense and lease surrenders, as well as increased manufacturing costs and selling and administrative expenses, contributed to the relatively unfavorable third quarter.

Goodyear

► Nine months ended Sept. 30: Net income amounted to $52,899,557, a decrease of 10.2 per cent compared with $58,917,842 earned in the first three quarters of 1959. Based on 33,207,597 shares of common stock now outstanding, net income was equal to $1.59 per share compared with $1.77 in the 1959 period. Consolidated net sales for the period were $1,184,526,548, a decrease of 1.6 per cent from the previous record of $1,203,521,662 set in the similar period of last year. According to E. J. Thomas, chairman of the board, who made the announcement, sales and profits of Goodyear's foreign operations had been running substantially ahead of a year ago.

Electric Autolite

► Nine months ended September 30: Net income amounted to $4,753,202, or $3.48 per share, compared to $5,631,773, or $3.59 for the comparable period of 1959. (The 1959 figure excludes a gain from the sale of the company's investment in Crane Co.) Net sales totaled $157,673,978, up from the figure of $143,720,333 reported for the same period of 1959.

U.S. Rubber

► Nine months ended Sept. 30: Net income of $26,504,560, equal to $3.76 a common share, was 4 per cent lower than the $26,504,560 or $3.94, reported for the like period last year. Sales of $739,624,625 compared with sales of $743,230,320 for the similar period of 1959. Included in the net income for the 1960 period were special credits of $1,950,000 or 34c a share, reflecting the net gain from the sale of the company's plant in Fort Wayne, Ind., and from prior years' tax accruals which were no longer required. H. E. Humphreys Jr., chairman, told stockholders that the company is battling higher costs, and that a stiff competitive situation in the rubber industry has prevented raising prices to recover these higher costs. "Our average cost for natural rubber during the first nine months of the year was about 25 per cent higher than during the same period last year. In addition, higher wage costs went into effect during the third quarter," he said.

Cooper Tire

► Nine months ended September 30: A net loss of $311,584 was reported by the company, compared to last year's net income of $1,004,570, or $1.16 a share, over the same period. Sales of $27,073,046 were down slightly from sales of $27,882,159 for the same period last year. Cooper directors omitted the common dividend for the fourth quarter, citing reduced earnings, higher costs and severe price competition. Wayne B. Brewer, president, said nine-month operations showed a $51,872 profit, but that inventory adjustments arising from recent declines in the market price of raw materials erased this profit.

Clevite Corp.

► Nine months ended Sept. 30: Net income rose to $5,109,985, equal to $2.65 per share, from $4,811,654, or $2.51, for the like period of 1959. Sales and other revenues totaled $73,097,662, up from the $62,448,415 reported for the corresponding period of 1959.

Seiberling

► Nine months ended Sept. 30: Net income was $143,633, a sharp decline from record-high earnings of $1,055,352 in the first nine months last year, and income was 2c per common share, contrasted with $1.56 a year ago. Net sales were $37,589,082, down 10 per cent from the $41,728,669 recorded in the first nine months of 1959. President J. P. Seiberling attributed the decline to tire market competition, "the most severe in over a decade." The sales decline was sharpest in truck tires, where Seiberling has a large proportion of its total volume, the company president said. He explained that truck tire sales are affected by general business conditions, "which continued to sag in the third quarter," adding that price-cutting slashed truck tire earnings. Not consolidated in the reported earnings was the company's equity in its investment in Copolymer Rubber & Chemical Corp., increased by 34c a share, compared with an increase of 46c a year ago.

Rubbermaid

► Nine months ended June 30: Net income climbed to $1,292,239, equal to 94c a share, from the $963,134, or 71c a share, reported for the like period a year ago. Net sales were at $20,498,443, as compared to $17,759,680 a year ago.

Baldwin Rubber

► Year ended June 30: Net income reported was $588,071, or $1.34 per share, down slightly from the $675,508, or $1.55 reported for the same period last year. Sales rose to $20,962,028, compared to $18,978,591 for the like period of 1959.

Simplex Wire

► Six months ended June 30: Net income sank to $497,000, equal to 83c per share, from $695,000, or $1.16 per share, in the like period of 1959. Sales were $18,381,000, as compared to $18,758,000 for the like period a year ago.

Raybestos-Manhattan

► Nine months ended September 30: Net income totaled $2,017,422, equal to $3.20 per share, compared with $2,803,696, or $4.40, for the like period of 1959.

Rubber on Display At Building Show

► Rubber materials used in modern building construction were on display at the 1960 Industrial Building Exposition and Congress, held on December 12 to 15, 1960, at the New York Coliseum, New York, N. Y. The exposition and congress, the first of its kind, consisted of two separate events running concurrently. The exposition, which occupied two floors of the Coliseum, presented exhibits of 115 companies and associations in displays valued at more than $2 million. Leading the discussions at the congress were 65 speakers representing virtually all types of companies, large and small, presently engaged in plant expansion or modernization.

Companies displaying rubber products for use in building construction were the Elastomer Chemicals Department of E. I. du Pont de Nemours & Co., Wilmington, Del.; Enjay Chemical Co., New York, N. Y.; and Products Research Co., Burbank, Calif. The DuPont exhibit displayed protective linings and coatings based on neoprene, Hypalon, and Viton synthetic rubbers; colorful roof coatings made with neoprene and Hypalon; and neoprene gaskets for curtain walls.

Enjay Chemical showed architectural components made with Enjay Butyl in a variety of forms ranging from very soft caulks and tapes through sponge stock up to molded and extruded shapes. Products Research Co. featured its PRC Rubber Calk in its display of its line of colored protective coatings and sealants, caulking compounds and adhesives.

Duffy Joins General Tire

► Frank A. Duffy, president of Duffy General Tire Co., Atlanta, Ga., has joined General Tire & Rubber Co., Akron, Ohio, as assistant to the president for operation. From 1953 to 1956, Mr. Duffy served as manager of the Retail Stores Division of General Tire. With his brother, Bernard J. Duffy, Mr. Duffy has operated two successful General Tire distributorships. He operated the Trenton, N.J., distributorship from November, 1946, until he was appointed to take over his first Akron assignment as retail stores manager. Since 1956, the Duffy brothers have operated as a partnership in Atlanta. With Mr. Duffy's new appointment, his brother, Bernard J. Duffy, will assume the presidency of the Duffy General Tire Co.

George A. Daum

Named by Goodrich

► George A. Daum has been named technical service manager for Hycar special purpose rubber for the B. F. Goodrich Chemical Co., in Cleveland, Ohio, responsible for all technical service activities for the product's customers. After graduating from Ohio State University in 1935 with a B.S. degree in chemistry, he served as a chemistry instructor at East High School, Portsmouth, Ohio. Following three years as a chemical supervisor at ordnance works in Charlestown, Ind., he joined B. F. Goodrich Chemical in 1945 as a chemical engineer in the firm's product application laboratory. In 1950 he was transferred to the Hycar Sales Department and in 1952 he was transferred to field sales covering Western Pennsylvania, New York, Vermont, and Western Massachusetts.

Phillips Staff Changes

► Assignment changes in the Rubber Chemicals Sales Division have been announced by Phillips Chemical Co., Bartlesville, Okla. C. H. Edwards, Jr., technical sales representative from the company's Dallas, Texas, office has been promoted to the post of manager of the Philprene specialty rubber plant at Borger, Texas, and George D. Covington has been transferred from Providence, R. I., to replace Mr. Edwards at Dallas. W. R. Haight, sales representative at Akron, Ohio, has been transferred to Providence, R. I., as technical sales representative, and F. J. Ennis has been added to the Chicago office staff as technical sales representative. The company has announced that the changes are being made because of expanding activities.

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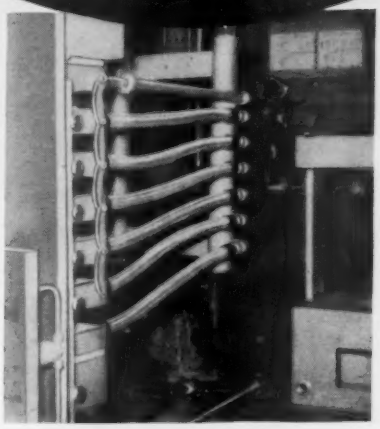

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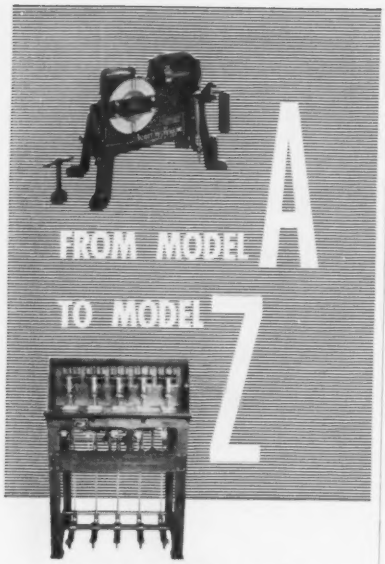

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E. M. Fettes

Appointed by Koppers

► Dr. E. M. Fettes, until recently director of research and development for the Chemical Division of Thiokol Chemical Corp., Trenton, N. J., has joined Koppers Co., Inc., Pittsburgh, Penna., as manager, Plastics Section, Research Department. The appointment is one of a series of changes in, and additions to, the Research Department staff in anticipation of the opening of the new Koppers Monroeville Laboratory Center. The company's Verona Center will continue its activities. Dr. E. W. Volkmann becomes manager of the Monroeville Center and Dr. F. L. Jones will be manager at the Verona Center. Dr. W. Conrad Fernelius, former head of the Chemistry Department at Pennsylvania State University, has joined Koppers as associate director of research. Dr. E. E. Donath has been named manager of contract research, Dr. C. F. Winans has been appointed European representative, and Dr. R. B. Spooner has been named manager of associated researches. Dr. Fettes was associated with the U. S. Rubber Co., New York, N. Y., and the Kendall Co., Walpole, Mass., prior to joining Thiokol Chemical Corp. He is a graduate of Massachusetts Institute of Technology and received his Ph.D. at the Polytechnic Institute of Brooklyn.

Goodyear Names Six

► Six executives of Goodyear Tire & Rubber Co., Akron, Ohio, have been promoted to new positions. They are: Howard L. Hyde, executive vice-president; Arden E. Firestone, vice-president and general counsel; Donald H. Walker, treasurer (who died several days after his appointment); R. L. Miller, secretary; Frank T. Quirk, assistant secretary; and Robert E. Sheldon, associate general counsel.

Mr. Hyde, who has been vice-president and general counsel for the last ten years, will have over-all responsibility for the financial and legal affairs of the company and will become a member of executive and finance committees. He assumes his financial duties as the result of the retirement of P. E. H. Leroy, vice-chairman of the board and chief financial officer. Mr. Hyde was a 1922 graduate of Ohio State University, and holds a law degree from Harvard University. He was formerly a member of the Cleveland, Ohio, law firm of Thompson, Hine and Flory, and has been a member of the board of directors since joining Goodyear in 1940 as general counsel and assistant secretary.

A University of Akron graduate, Mr. Firestone also holds a law degree from the University of Michigan. He was a partner in the Akron law firm of Hutchison & Firestone from 1932 to 1942. In 1942 he joined Goodyear as an attorney. Mr. Walker attended the University of Akron and has been with Goodyear since 1933. He has had numerous overseas assignments. Mr. Miller is a chemical engineering graduate of Purdue University and a graduate of Akron Law School. He joined the company as a tire compounder and later transferred to the patent department. He was also secretary to Goodyear's former chairman and assistant secretary of Goodyear Aircraft Corp. He has been Goodyear's patent counsel since 1949.

Mr. Quirk is a graduate of Boston College and a lawyer. He started his career with Goodyear in 1934 as a credit clerk in Boston. Mr. Sheldon, who is head of Goodyear's law department, is a graduate of Ohio Northern University and Akron Law School and has been with Goodyear for 38 years.

► "Basic Guide to Ferrous Metallurgy," offered by Tempil Corporation, New York, N. Y., is designed to serve as a standard reference source for the engineer, metallurgist and skilled worker.

► Descriptive literature on the Triphane absolute 3-micron filter-hose-coupling assembly for converting existing hydraulic service carts has been made available by Aircraft Porous Media, Inc., Glen Cove, N.Y.

West Coast News

► Norman A. Klemp has been named vice-president of Pacific Moulded Products Co. Mr. Klemp will continue as plant manager. He is a native of Minnesota. He holds a chemistry degree from St. Olaf College, Northfield, Minn., and an M.S. degree in chemistry from North Dakota State College in Fargo. He is a member of the American Chemical Society, TLARGI Rubber Group, and has been associated with the rubber industry for 18 years. William Long, formerly of the Clevite-Harris Co., has joined PMP as technical director in charge of research and laboratories. Mr. Long will guide the firm's engineering and development of mechanical rubber and plastic parts for aircraft, industrial, commercial, petroleum and military applications. He also will supervise technical aspects of production of molded phenolic fiberglass products and molded, extruded, and metal-bonded parts.

► The Armstrong Rubber Co., West Haven, Conn., has announced that it will build a $25 million factory, warehouse and administration building near Hanford, Calif. Construction is expected to begin in late January. The new facilities will encompass over one million square feet and will cover 80 acres of the 320-acre site purchased by Armstrong. Provisions have been made for a 465,000 square foot addition, to be completed at a later date. James J. Walsh, Jr., member of the board of directors, will be in charge of the new facilities, which will include West Coast sales offices. Initial capacity will be 10,000 tires a day.

► Archie J. Smith has been named by Stewart Bolling and Co., Inc., Cleveland, Ohio, to establish West Coast headquarters for the company in Woodland Hills, Calif. He will be responsible for both sales and service, and the branch will handle Bolling's entire line of new and rebuilt machinery. Mr. Smith has spent 20 years in sales capacities in both the metal-working and non-ferrous lines and has been on the Pacific Coast for 15 years.

► The Los Angeles Rubber Group held its annual Christmas party dinner dance on December 2 at the Cocoanut Grove of the Ambassador Hotel in Los Angeles.

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Canadian News

► Polymer Corp., Sarnia, Ontario, is reportedly ready to announce more details on a $40 million program to broaden its production at home and build up its competitive position in world-wide rubber markets. The over-all program will, it is said, boost Polymer's capacity from 150,000 to 200,000 tons a year. About 65 per cent of total production is now going to export markets. Polymer's first overseas project, already announced, will be a specialty rubber plant to be established in France in the Common Market area. The biggest home outlay will be a $6 to $8 million expenditure on the first polybutadiene plant in Canada, and Polymer has already announced plans to install $1.5 million facilities at its Sarnia plant for the production of a range of black masterbatch rubbers.

These moves, to assure Polymer a competitive position in world trade, are following a full-scale cabinet committee inquiry into the problem caused by the fact that the corporation's production far exceeds domestic demand—earlier in the year it was estimated that 2½ times the amount of synthetic rubber needed domestically would be produced by Polymer in 1960. The special government committee set up to study Polymer's position felt the new moves—including plans to move into butyl rubber production in the United Kingdom—were much more urgent than a decision on whether the company remains a crown corporation or be sold into private hands. "We're going ahead with the expansion now without thought as to whether the government will sell Polymer or not," Defense Minister O'Hurley indicated. "We want to hold the markets we have over there." He also, however, stressed the point that the government has not given up its idea of eventually selling Polymer, providing a way can be found to insure that its ownership would stay in Canada and that the price was right.

Construction of the new black masterbatch facilities at Sarnia will start soon and be completed late next year. The new rubbers are mixtures of synthetic rubber and carbon black and will find wide use in the manufacture of tires, tire retreading material and a variety of mechanical goods, it is said.

Polymer's overseas operations will utilize overseas supplies of butadiene and styrene, but the manufacturing range of the Sarnia operation will be broadened by the addition of further rubber-making steps and production of polybutadiene type rubbers, which will mean, before long, construction of additional butadiene capacity in the Sarnia area. Right now the crown company's operations are drawing on United States imports in addition to local supplies from its own plant and from an Imperial Oil plant. The new type rubber, in the planning stages for some time, will at first find specialized use, such as in production of bus and truck tires, but in time it is expected to start replacing other types of synthetic rubber products. Bidding on the new plant contract is already open.

Overseas Expansions

Polymer's new course has already provoked industry speculation, in view of rapid overseas expansions already undertaken by other companies in Europe, Commonwealth countries and in Japan. Available overseas raw material sources are already being tied up in long-term contracts, it has been pointed out. In commenting on Polymer's move to keep up with the trend, R. C. Berkinshaw, chairman, Goodyear Tire and Rubber Co. of Canada, Ltd., New Toronto, Ontario, said, "This is a wise move and a very necessary one if Polymer is to hold its competitive position in world markets." But Canadian industry is not entirely in agreement on the feasibility of this alliance between Ottawa and overseas investment. "It is a unique thing to see a crown company moving into overseas operations along with private capital," said W. O. Twaits, president of Imperial Oil. "How far does the crown company think it can go in this very broad organic chemicals field."

But Defense Minister O'Hurley, on the other hand, points out that both the British and the French are quite familiar with this type of operation, with similar tie-ups within their own economies. "Reports from France and Britain are that they look very favorably on the expansion plans over there." Nevertheless, there is much speculation on exactly what Polymer's overseas policy will be in the face of strongly entrenched domestic competition where a government controlled Polymer could be a political liability, and reports that a Standard Oil of New Jersey affiliate is trying to beat Polymer to the punch in establishing a butyl plant in the United Kingdom have raised the question of how much actual competing Polymer is prepared to do when it is no longer only a question of a market to fill.

As far as the funds which will go into Polymer's overseas expansion, some of the new investment money will probably come from overseas oil refining and petro-chemical firms which in turn might guarantee long-term supplies of basic raw materials. Other funds may come from La Banque de Paris et des Pays Bas (Bank of Paris and the Netherlands). Any spending on the Canadian expansion will come out of Polymer's own revenues, but Defense Minister O'Hurley has stated that the Canadian government is prepared to put up money for the overseas expansion program in the future, if necessary, in the form of advances on Polymer earnings.

► The Division of Rubber Chemistry of the Chemical Institute of Canada, in conjunction with the Ontario Rubber Group, will present an advanced course in Rubber Technology, to be given at the Ryerson Institute of Technology, beginning January 11. Lecturers and their topics are: Dr. B. M. E. Van der Hoff, (Polymer), "Mechanism and Kinetics of Emulsion Polymerization"; E. B. Storey and M. J. G. Davidson, (Polymer), "Styrene-Butadiene and Nitrile-Butadiene Rubbers"; F. Wayne Keeley (DuPont), "Neoprene and Hypalon"; Dr. R. T. Woodhams, (Dunlop), "Solution Polymerization"; Dr. J. Manton, (Polymer), "Butyl Rubber"; Dr. L. A. McLeod, (Polymer), "Polyisoprene, Polybutadiene"; Dr. Irwin J. Schaffner, (U. S. Rubber), "Natural Rubber"; Dr. C. Sweitzer, (Columbian Carbon), "Carbon Black (1)"; E. M. Dannenberg (Cabot Corp.), "Carbon Black (2)"; and E. H. Schwartz, (Southern Clay), "Non-Black Fillers." The course chairman is W. J. Nichol. The prerequisite for the course is completion of the basic rubber technology course or equivalent.

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Overseas

Madrid—Dow Chemical Co., Midland, Mich., and Union Quimica del Norte de Espana S.A. (Unquinesa) have reached an agreement for construction of a petrochemical complex in Spain. Under terms of the agreement Dow will purchase a new issue of Unquinesa stock. The Spanish company, which will probably change its name to Dow-Unquinesa S.A., will be entitled to technological, engineering and marketing assistance from Dow. Plans call for the construction of a cracking unit to produce ethylene and propylene and for the recovery of butadiene. The Spanish company will manufacture polyethylene, polypropylene, and polystyrene.

Tokyo—The Japanese Government is considering levying import duties on synthetic rubber for the protection of the domestic synthetic rubber industry. Spokesmen for the Trade and Finance Ministries have said a 10 to 15 per cent duty is under consideration. However, the Japan Rubber Manufacturers' Association has expressed the opinion that such a move might prove unwise as other countries might retaliate by raising import duties on Japanese goods.

Rome—The U.S. Rubber Co., New York, N. Y., and Rumianca, S.p.A., Torino, Italy, have signed a technical service agreement for the production of polyvinyl chloride resins at a plant to be built by Rumianca at Pieve Vergonte, Italy. The plant, expected to cost about $3 million and due to be in production by mid-1962, will produce about 10,000 metric tons of resinous copolymers and polymers of vinyl chloride annually. The agreement provides for patent licenses to the Rumianca firm for the manufacture and sale of the vinyl resins in Italy, and for the use and sale of the products in other parts of the world.

Paris—The first tire manufactured at the new Goodyear plant at Amiens, France came off the production line exactly one year after construction of the $7 million facility began. Production at the plant will include complete lines of passenger, truck and farm tires and tubes for replacement and original equipment in the French and common European markets and for export.

Belfast—Bridgeport Brass Co., Bridgeport, Conn., has started production of tire valves, bicycle valves and accessories at a 73,000 square foot plant at Lisburn, Northern Ireland. The company has formed a wholly-owned subsidiary, Bridgeport Brass, Ltd., with headquarters in London, to carry on the operation. The plant, owned by the government, is leased.

This is one of the proudest men in the rubber industry. *Why*? If you make things containing rubber, the cause of his pride can mean a great deal to you.

You see, his pride is in his company, its products and policies, and his associates—as well as in himself. *This is important.* More than 15 years ago, he began with Copolymer as a lab trainee. He advanced steadily, performing a variety of increasingly demanding, challenging jobs that taught him a lot about rubbers and their uses . . . but not everything. *He learned (and hasn't forgotten) that what he DOESN'T know is available from others at Copolymer who DO know.*

He was, he realized, a responsible part of a company run by "the best group of management men in the rubber industry," men who "had a world of confidence in the future" and who "backed their products and employees 100 per cent."

Proud of Copolymer's *customer-minded* outlook and the company's relentless search for new, *better* products, he knows Copolymer's accomplishments . . . he has seen customer after customer gain from Copolymer SERVICE. He believes the driving force behind Copolymer's long list of successes is *pride in being better.*

I know he does—I'm this Copolymer sales representative. I *am* proud of my company, for good reason. I would like to serve you. I'm at your command any day, any time . . . backed up by the entire Copolymer organization.

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No. 13

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IMPROVE TENSILE ON YOUR BUTYL RECLAIM

Preliminary tests and reports from users indicate that our 4039-Y Reclaiming Oil improves tensile on butyl reclaim. The resulting stocks show easier processing characteristics and higher physical properties than can be expected from other reclaiming oils.

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P.S. Use our "Maglite® D" in your Neoprene batches and avoid scorching entirely!

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Past-presidents who attended the Fifth Annual Past-Presidents' Night held by the Northern California Rubber Group are, left to right: William H. Deis (Merck & Co.); Ralph T. Hickcox (Oliver Tire); Halsey C. Burke (Burke Rubber); Russell D. Kettering (Oliver Tire); Fred W. Swain (R. D. Abbott); Drace Kutnewsky (Burke Rubber); and William D. Good (American Rubber).

NCRG Honors Its Past-Presidents

► The Northern California Rubber Group honored seven of its seventeen past-presidents at its Fifth Annual Past-Presidents' Night held on October 13 at the Elks' Club in Berkeley, Calif. Past-presidents attending the event were: Halsey C. Burke (Burke Rubber); William H. Deis (Merck & Co.); William G. Good (American Rubber); Ralph T. Hickcox (Oliver Tire); Russell D. Kettering (Oliver Tire); Drace Kutnewsky (Burke Rubber); and Fred W. Swain (R. D. Abbott). Following the regular business meeting and dinner, James F. Carey, of the management consultant firm of McKinsey & Co., San Francisco, spoke on the subject, "Building Your Management Job."

New U.S. Rubber Tires

► A full line of passenger tires with white sidewalls less than an inch wide has been introduced for the replacement market by U.S. Rubber Co., New York, N.Y. The company reports that the move follows acceptance of the new tire style as standard equipment on three 1961 compact cars: Buick Special, Oldsmobile F-85, and Chevrolet Corvair. In addition to the sizes which fit these cars, 6.50/13 and 7.00/13, the slim whitewall replacement line includes four 14-inch and three 15-inch sizes: 7.50/14, 8.00/14, 8.50/14 and 9.00/14, and 7.60/15, 8.00/15 and 8.20/15.

McCarthy in New Post

► U.S. Rubber Reclaiming Co., Inc., Buffalo, N. Y., has named James J. McCarthy to supervise sales and technical service for its new $1,250,000 plant at Vicksburg, Miss., which started production on November 29, 1960. A graduate of the University of Detroit, Mr. McCarthy has done graduate work in chemistry at the University of Akron. He has been associated with Firestone Tire & Rubber Co., as a process engineer. Prior to his present appointment, Mr. McCarthy handled sales for U.S. Rubber Reclaiming in mid-western and south-eastern states.

Velsicol Names Kirk

► Velsicol Chemical Corp., Chicago, Ill., has appointed John F. Kirk, vice-president since 1954 and a member of the board of directors since 1958, executive vice-president of the company. Bernard H. Lorant, previously assistant to the president in charge of research, has been named vice-president in charge of research and has also been elected to the board of directors. A. B. Chadwick has been named vice-president in charge of manufacturing and engineering. Mr. Chadwick was formerly director of manufacturing and engineering.

Mobay Awarded Patent

► U. S. Patent 2,948,691, pertaining to reaction products of polyether resins and polyisocyanates, has been awarded to Mobay Chemical Co., Pittsburgh, Penna. Mobay feels that the initial commercial importance of the patent lies in the production of polyether-based urethane foams, and has announced its intention to grant royalty-free licenses to foam producers. Under terms of an interference settlement which preceded issuance of the patent, E. I. du Pont de Nemours and Co., Inc., Wilmington, Del., will have equal rights.

LOOKING FOR A

BLACK

Non-extended Masterbatch?

TRY 8155...

It gives you the excellent properties of a cold rubber plus very high abrasion resistance and improved processing and mixing (aided by the addition of 12.5 parts of processing oil). The high quality of this polymer makes it particularly suited for premium tire treads and high-quality, high-abrasion mechanical goods.

Description:

Polymer Type	SYNPOL 1500
Oil	Highly Aromatic, 12.5 Parts
Carbon Black	ISAF
Emulsifier	Rosin Acid
Stabilizer	Staining
Coagulant	Acid

TYPICAL PRODUCTION VALUES

Chemical:

Volatile Matter, % wt.	0.2
Ash, % wt.	0.18
Organic Acid, % wt.	3.84
Soap, % wt.	0.9
Carbon Black, % wt.	31.7
Oil, % wt.	7.11

Physical:

Compound Viscosity, ML-4 @ 212°F.	52
Tensile Strength, 50′ Cure @ 292°F.	3600
Elongation, 50′ Cure @ 292°F, %.	560
Modulus @ 300% Elongation, psi	
25′ Cure @ 292°F	1250
50′ Cure @ 292°F	1640
100′ Cure @ 292°F	2000

Test Recipe:

SYNPOL 8155A	146.00
Zinc Oxide	5.00
Sulfur	2.00
MBTS	2.00
Stearic Acid	1.50

...one of the reliable

SYNPOL®

SBR'S

Obituaries

George A. Allison, Sr.

► George Aloyd Allison, Sr., retired manager of technical information for the B. F. Goodrich Co., Akron, Ohio, died October 26 at his home in Akron. He was 70 years old. Mr. Allison joined Goodrich in 1917 after his graduation from Pennsylvania State University and was first employed in the general chemical laboratories. He was technical superintendent of processing from 1929 to 1943 when he was assigned to the Government in the Office of Rubber Director of the War Production Board in Washington, D. C., serving there until January, 1946. On his return to Akron he became Goodrich manager of technical information, serving a second tour of Government duty with the National Production Authority from February, 1951 through December of that year. In 1955 he retired.

Mr. Allison was a member of the American Chemical Society and the American Institute of Chemical Engineers, as well as past president of the Akron Rubber Group. He is survived by his wife, a son, and a daughter.

Benjamin H. Davis

► Benjamin H. Davis, well known in the wire and cable industry and a founder of the Davis-Standard Co., Mystic, Conn., died November 25 at his home in Noank, Conn. He was 56 years old. Mr. Davis had been a vice-president in charge of engineering and sales for Standard Machine Corp. and vice-president and a director of the Franklin Research and Development Corp. of Boston, Mass. He is survived by his wife and son.

Raymond B. Nichols

► Raymond B. Nichols, a technical engineer in the Research and Development Department of the Goodyear Tire and Rubber Co., Akron, Ohio, died November 23. Mr. Nichols graduated from Purdue University and joined Goodyear shortly after. He was with the company for 41 years. Survivors are his wife and two daughters.

Richmond Chipman

► Richmond Lane Chipman, retired rubber industry executive, died at his home in Montclair, N. J., after a long illness. He was 85 years old. An 1898 graduate of Harvard College, he was with George A. Alden and Co., Boston, Mass., from 1898 to 1913. He handled the company's New England and Canadian sales program and later managed its overseas plantations. In 1913 he opened his own brokerage company in crude rubber, maintaining his firm until 1932 when he retired for a year because of ill health. Mr. Chipman then held executive posts with Fred Pusinelli and Co. and J. N. Dunbar and Co., both in New York, N. Y., and the Frank B. Ross Co., Hoboken, N. J., as head of the East Indian and South American Products Division. In 1947 he and a group of associates formed the Ross-Allen Co. and he served as the company's secretary until his retirement in 1957. He is survived by his wife, a son and two daughters.

R. H. Wattleworth

► Robert H. Wattleworth, director of Akron services for the B. F. Goodrich Co., Akron, Ohio, died November 22 at Akron City Hospital after a long illness. He was 60 years old. An engineering graduate of the University of Michigan, Mr. Wattleworth taught at Case Institute of Technology, Cleveland, Ohio, for two years. He joined Goodrich in 1926 and held a variety of positions until he was named general superintendent of the Processing Division in 1946. He became director of Akron services in 1953. He is survived by his wife, a son, and a daughter.

William D. Egleston

► William D. Egleston, manufacturers' representative, of William D. Egleston Co., Cambridge, Mass., died on October 13 at his home in Cambridge. Mr. Egleston was a member of the Boston, Connecticut and Rhode Island Rubber Groups as well as the Rubber Division of the American Chemical Society. He is survived by his wife and two sisters.

Robert Harwick

► Robert Harwick, executive of E. I. du Pont de Nemours, Wilmington, Del., died May 19 of a heart attack while attending a sales conference in Cleveland, Ohio. He was 48 years old. Mr. Harwick served as assistant manager of the Akron office of the company's Elastomer Chemicals Department from 1955 to 1956, leaving Akron to become Western regional manager of the Petroleum Chemicals Division of the Organic Chemicals Department with headquarters in Los Angeles.

Franklin A. Miller

► Franklin A. Miller, who retired last year as director of the Marketing and Merchandising Department of Raybestos Manhattan, Inc., Passaic, N. J., died May 18 in Fort Lauderdale, Fla. He was 72 years old. Mr. Miller was a graduate of Northwestern University, a former director of the National Standard Parts Association of the automotive industry, and former president of the Friction Materials Standards Institute. He is survived by his wife, a son, and a daughter.

Carbon Black Process

► Two Pennsylvania State University researchers, Masayuki Kawahata and P. L. Walker, Jr., have advocated a method of manufacturing carbon black from anthracite. Their proposed commercial process involves treatment of the coal with steam—liberating hydrogen and carbon monoxide—followed by high-temperature treatment with chlorine gas. The chlorine treatment serves to remove major anthracite impurities. Under optimum conditions, a gram of activated carbon made from anthracite would adsorb 0.7 grams of carbon tetrachloride gas.

New Foam Firm Formed

► Stauffer Chemical Co., New York, N.Y., and Hewitt Robins, Inc., Stamford, Conn., have formed a new company, Stauffer-Hewitt, Inc., to manufacture polyurethane foam products for cushions, bedding and building panels. Under the terms of the agreement, Stauffer purchased two-thirds interest in Hewitt-Robins' Urethane Foam Division. The purchase price was not revealed.

CRG Hears of X-rays In Rubber Industry

► "X-ray, A Valuable Tool of the Rubber Industry," was the subject of a talk given by Raymond C. Lindert (Armstrong Rubber) at the Annual Fall Meeting of the Connecticut Rubber Group on November 18, 1960, at Rapp's Paradise Inn, in Ansonia, Conn. The meeting was a combination technical session and Sports Night. The Sports Night guest speaker was Ralph Houk, manager of the New York Yankees.

Prior to his discussion of the X-ray as a control, research, and inspection method in the manufacture of tires at Armstrong, Mr. Lindert covered the history, properties and methods of the X-ray. He explained that since Roentgen's discovery of 1895, the X-ray has been a widely used and well known servant of the medical profession. However, he pointed out, for over a quarter century this same X-ray has been playing an increasingly important role in industry in control, research, and inspection.

According to the speaker, an outgrowth of X-ray was fluoroscopy and radiography. He then discussed the use of the various X-ray methods at Armstrong Rubber. He pointed out that fluoroscopy does not meet

Raymond C. Lindert

Armstrong's requirements since known defects found by other means could not be detected when tires were fluoroscoped. However, Mr. Lindert continued, radioscopy, particularly Xeroradiography, developed by Halloid Co., approaches the low cost and fast inspection rate of fluoroscopy, but is vastly superior in sensitivity to detail, exceeding that possible with X-ray film.

Mr. Lindert stated that as in any industry, major efforts are made to encourage pride in workmanship. In this regard, he pointed out, the X-ray of an uncured tire can show tire building deficiencies which are normally covered up by subsequent building operations.

Develops New Plioflex

► A new intermediate viscosity rubber masterbatch, called Plioflex RMB 224, which combines synthetic rubber and a reinforcing resin, has been developed by the Chemical Division of Goodyear Tire & Rubber Co., Akron, Ohio. Designed as a general purpose material, the new substance is said to be especially suited to shoe soling and other light colored compounds that require high abrasion resistance. Other qualities of the material, according to the company, are good hardness and stiffness characteristics, and excellent tear resistance, tensile strength and mold flow properties.

M. J. Rhoad, manager of the Rubber Department, states that the industry trend is toward lower viscosity rubbers, and to obtain maximum advantage from a high styrene reinforcing resin, it must be thoroughly dispersed in the rubber. He explained that Goodyear has solved this problem by blending Pliolite resin latex into Plioflex rubber latex and coagulating the two together in a carefully controlled process. The resulting masterbatch processes easily, both on mills and Banbury mixers, he added. The new rubber is also produced in a free-flowing crumb form that is packaged in Kraft paper bags. The product handles easily and does not become compacted during storage, he pointed out.

Amerace Negotiating

► Amerace Corp., New York, N. Y., is negotiating to acquire Elastic Stop Nut Corporation of America, Union, N. J. Under the tentative agreement, subject to the approval of both firms' boards of directors and stockholders, four shares of Elastic Stop Nut common stock would be exchanged for one share of a new Amerace $100 par value, $5.00 dividend voting cumulative convertible preferred stock. Amerace, active in the woolen and worsted industry, recently diversified its activities through a merger with American Hard Rubber Corp., into the fields of chemicals, plastics, rubber, fiber glass, battery components, garden hose, and wire.

LOOKING FOR A

COLD

Non-extended SBR?

TRY 8104...

It features excellent physical properties and color plus excellent processing, smooth finish and controlled shrinkage ...a valuable combination for such applications as footwear, open and closed cell sponge and mechanical goods.

Description:

Polymer	Low Mooney, Cold Type
Emulsifier	Fatty Acid
Coagulant	Alum
Stabilizer	Non-staining, Non-discoloring

TYPICAL PRODUCTION VALUES

Chemical:	
Volatile Matter, % wt.	0.12
Ash, % wt.	0.91
Organic Acid, % wt.	5.15
Soap, % wt.	0.05
Bound Styrene, % wt.	23.3
Physical:	
Mooney Viscosity, ML-4 @ 212°F.	30
Compound Viscosity, ML-4 @ 212°F.	39
Tensile, psi, 50' Cure @ 292°F.	3400
Elongation, 50' Cure @ 292°F, %	640
Modulus @ 300% Elongation, psi	
25' Cure @ 292°F.	650
50' Cure @ 292°F.	1125
100' Cure @ 292°F.	1450
Water Absorption, mg/cm²	1.2

Test Recipe:	
SYNPOL 8104	100.00
EPC Black	40.00
Zinc Oxide	5.00
Sulfur	2.00
MBTS	2.00

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SYNPOL® SBR'S

Volkman Named Manager

► Roy G. Volkman, who has held both development and production positions with U.S. Rubber Co., New York, N. Y., has been named development manager for the firm's Mechanical Goods Division. His headquarters will be at the Passaic, N. J., plant, where the division's research laboratories are centered. Mr. Volkman graduated from Lafayette College with a B.S. degree in chemical engineering. During his 24 years with U.S. Rubber, Mr. Volkman has been in research and development of new products and in quality control. Prior to his present assignment, he was general superintendent of production of synthetic fibers at the Providence, R. I., plant, a post he assumed in January, 1960. Mr. Volkman is a member and past-chairman of the Rhode Island Rubber Club, and has been a national director of the American Society for Quality Control.

Rubber Safety Record

► According to the National Safety Council, the only chemical process industry to better the chemical segment in accident frequency rate was the rubber industry with a record low mark of 2.49. The chemical process industries set a new low in 1959 for the 18 segments of the industry, with an accident frequency record of 3.32. Accident frequency is measured by the number of disabling injuries per million man-hours worked. The rubber industry also topped the CPI in accident severity rate with a low 337. The CPI accident severity rate, measured by the number of days lost per million man-hours worked, was 495 in 1959. Compared with other industries, the CPI ranked sixth lowest in accident frequency rate, but only 16th in accident severity rate.

Shively Retires

► Walter E. Shively, said to be the dean of tire design, has retired from the Goodyear Tire & Rubber Co., Akron, Ohio, after 45 years of service. Mr. Shively has been in charge of Goodyear's tire engineering development since 1931. He designed the first pneumatic tire for trucks. In 1947, he received the Litchfield Award of Merit for the Goodyear Super Cushion tire which set a standard for original low pressure tires.

The 36-man overseas technical-sales group of Cabot Corp. They are, left to right, back row: Geoffrey de Bagneux (France); Len MacQueen (United Kingdom); Reg Laffoley (United Kingdom); Ed Cheetham (United Kingdom); Vincent Maraux (France); David Christopher (United Kingdom); Don Patterson (France); Henri Figielski (France); Ray Rossman (U. S.); Eli M. Dannenberg (U. S.); Iain Horn (United Kingdom). Middle Row: Don Harper (France); Guy Kuderer (France); Amendo Caliendo (Italy); Carlo Beer (Italy); Piero Pasetto (Italy); Rollo Belsham (United Kingdom); Bill Campaigne (United Kingdom); George Cash (United Kingdom); Denis O'Mulloy (France); James Satterfield (United Kingdom); Bert King (United Kingdom); Brian Thorley (United Kingdom); Bob Wood (United Kingdom); Daniel Lassailly (France). Front Row: George Raymond (France); Ron Holder (U. S.); Tom Bolt (U. S.); Art Dobbin (U. S.); John Andrews (U. S.); Bill Loving (U. S.); Ed Eaton (France); Umberto Massari (Italy); Charlie Beech (Italy); Neville Scott (United Kingdom); Claude de Sercy (France).

Cabot's Overseas Group Meets

► The 36-man overseas technical-sales group of Cabot Corp., Boston, Mass., met recently in Surrey, England, to discuss ways and means of improving and extending present technical and sales services to the greatest benefit of customers in every overseas country where Cabot Corp. is represented. The group, said to be the largest of its kind in the carbon black industry, gathered from England, France, Italy, and Boston, Mass. Chairman of the meeting was W. L. Loving, vice-president of Carbon Black Research and Domestic Production. John Andrews, assistant director of the International Division, opened the meeting. Speakers included Raymond P. Rossman, director, Carbon Black Technical Department and Carbon Black Technical Service; Eli M. Dannenberg, director, Carbon Black Research Department; Thomas D. Bolt, manager, Domestic Technical Service; Rollins E. Dobbin, director, Carbon Black Research and Development, Pampa, Texas; Edward R. Eaton, European Technical Manager; and Brian R. Thorley, technical advisor for Carbon Black Operations in Europe.

The Surrey meetings preceded the official opening of Cabot's fifth overseas company, Cabot Italiana S.p.A. Other Cabot overseas companies are Cabot Carbon of Canada, Ltd.; Cabot Carbon Ltd.; Cabot France S.A.; Cabot Europa; and the jointly-owned firm of Australian Carbon Black Pty. Ltd.

Goodyear Space Fabrics

► A Goodyear scientist stated in a paper presented at the 15th Annual Meeting of the American Rocket Society that expandable fabrics for building tomorrow's manned space stations and the rocket boosters to fire them into orbit are available now. In his paper, Frederick J. Stimler, engineering specialist for Goodyear Aircraft Corporation, Akron, Ohio, said that the available fabrics may be of fiber or metal woven cloth, impregnated with materials to make them leak-proof and resistant to high temperatures. "Fabric stations can be folded and packaged into suitable containers for boosting into orbit. Once in orbit, the folded stations can be inflated into shape," he commented, going on to say that expandable sections can be used to form even larger stations and the walls rigidized through the injection of quick-setting lightweight plastic foam, giving the station added structural strength.

Goodyear Employees Agree on Standards

► A union-management agreement calling for new production standards at Plant 2 of the Goodyear Tire and Rubber Co., located in Akron, Ohio, has been reached, paving the way for an $8 to $10 million modernization investment featuring the installation of new tire machines designed and built by the company. In October, the company is said to have warned Local 2 of the United Rubber Workers that it might have to close Plant 2 unless output efficiency could be brought up to the level of other factories. Although the average hourly wage for the Akron plant workers is higher, Goodyear plants in Gadsden, Ala.; West Topeka, Kans.; Los Angeles, Calif.; and Jackson, Mich., have had higher production rates. The Plant 2 agreement calls for new production rates based on a piece-work system designed to make operations more competitive.

The agreement followed four weeks of negotiations on the establishment of a rate for recently-installed tire machines. Walter H. Rudder, manager of domestic tire production for Goodyear, put the problem up to the 1,450 workers at the plant in a series of 33 meetings held in October, pointing out that this was the highest cost passenger tire plant in the Goodyear system. He outlined the company's tentative plans for plant modernization, calling for an answer to the question: "If Goodyear management is willing to spend millions of dollars to modernize Plant 2, are you, the employees, willing to accept the responsibility of operating the equipment as it would be operated in another location?"

According to R. B. West, factory personnel manager at Goodyear, now that the agreement has been reached concerning a specified number of tires to be produced in a given length of time, Goodyear will be in a position of being able to proceed with an extensive modernization program at the plant "provided the requirements of the new rate are met and with the continuing cooperation of the union and employees." Goodyear will reach its final decision on the expansion plans for the plant based on the experience it has with the first of the new tire machines which have been installed.

The company does not foresee any substantial change in the work force employed at Plant 2 as a result of the modernization, but the company has stated that it would not be possible to forecast total employment in definite terms until plans are further along. The average hourly rate for Akron workers is now $3.03 an hour, and a company spokesman said that while it would not be possible to say what the new Akron rate would be, the indications were that Akron workers would not lose any pay.

P. C. Finn

Named by G-E Silicone

► Parker C. Finn has been named sales representative for the Eastern sales district of the Silicone Products Department of the General Electric Co., Waterford, N. Y. He is located in Newark, N. J. A 1955 graduate of the University of Detroit with a chemical engineering degree, Mr. Finn joined the General Electric Co. in 1955 on the Chemical and Metallurgical Training Program. He has held assignments in the Lamp Division, the Metallurgical Department, the flight propulsion operation, and became associated with the Silicone Products Department last February.

Firestone Two-Ply Tire

► A two-ply tire, lighter than the four-ply tire and said to offer somewhat softer riding qualities, is now being developed by the Firestone Tire and Rubber Co., Akron, Ohio, for possible use as original equipment on compact cars. Still in the experimental stage, the tire is currently being tested on compact models by several automobile manufacturers. Firestone started experimenting with two-ply tires in 1952, and has produced two-ply tires for original equipment on small lightweight cars in Europe and as replacement tires for these foreign cars in this country.

LOOKING FOR A

HOT

General-purpose SBR?

TRY 1061 . . .

It's an easy processing non-staining, non-discoloring polymer, stabilized for maximum resistance to breakdown and gel formation during milling . . . especially suited for light-colored and white products such as white sidewalls, soles, tile, toys, proof goods and sporting goods. (Also, ask about 1061C, the preferred polymer for high impact styrene.)

Description:

Polymer . . . . . SYNPOL 1061
Emulsifier . . . . . Fatty Acid
Stabilizer . Non-staining, Non-discoloring
Coagulant . . . . . Salt Acid

SPECIFICATIONS

Chemical:

Volatile Matter, % wt. . . . . 0.50 max.
Ash, % wt. . . . . 1.50 max.
Organic Acid, % wt. 4.00-6.00
Soap, % wt. . . . . 0.75 max.
Bound Styrene, % wt. 22.5-24.5
Stabilizer, % wt. . . . . 1.25 added

Physical:

Raw Viscosity, ML-4 @ 212°F 44-52
Compound Viscosity,
ML-4 @ 212°F . . . . . 73 max.
Tensile Strength,
50′ Cure @ 292°F . . . . . 2500 min.
Elongation,
50′ Cure @ 292°F, % . . . . . 500 min.
Modulus @ 300% Elongation, psi
25′ Cure @ 292°F 325-625
50′ Cure @ 292°F 750-1100
100′ Cure @ 292°F 1200-1600

Test Recipe:

SYNPOL 1061 . . . . . 100.00
EPC Black 40.00
Zinc Oxide 5.00
Sulfur 2.00
MBTS 1.75

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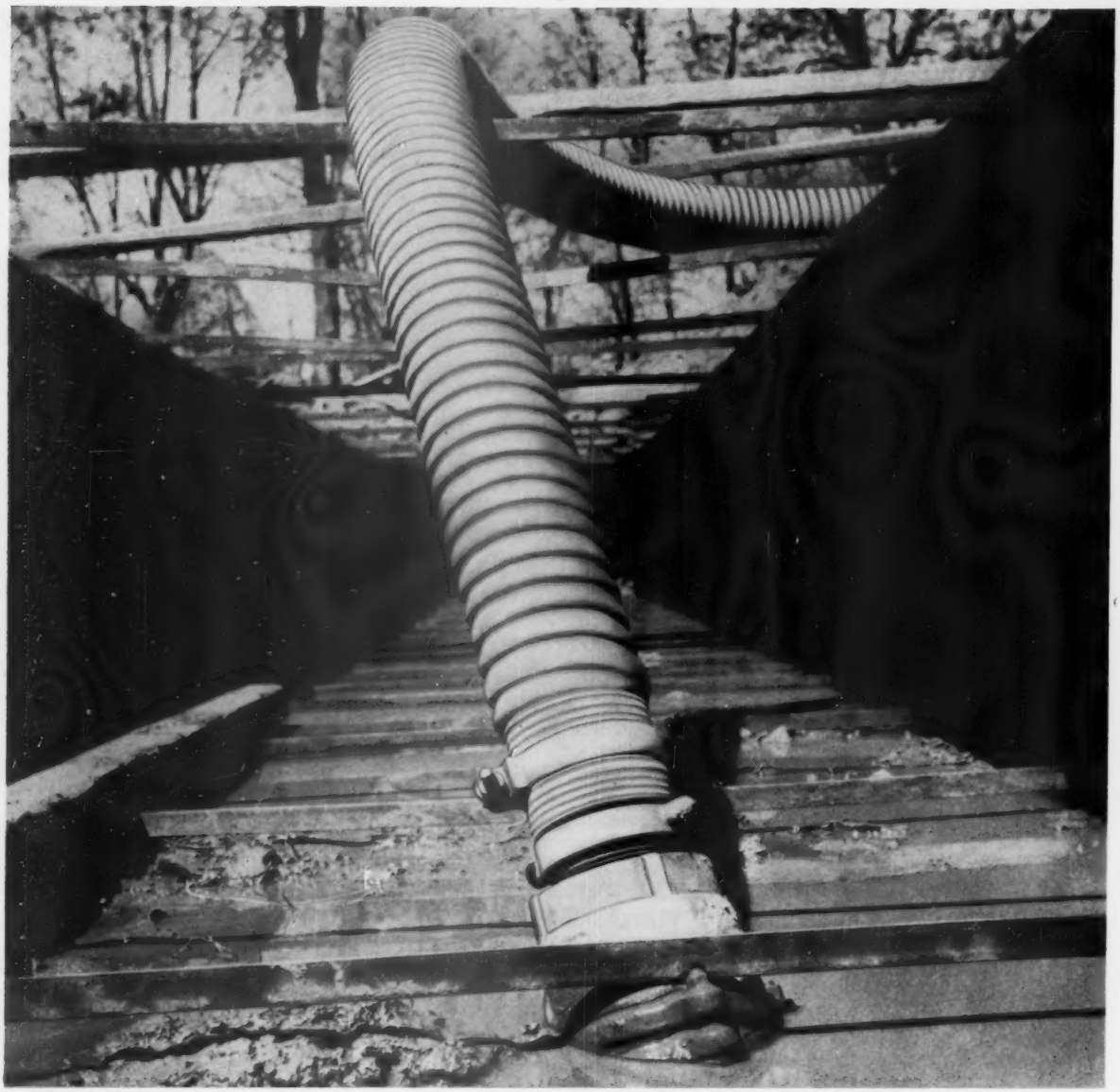
SYNPOL® SBR'S



PRESSURE PYTHON—Time, always an important factor in the construction industry, figured importantly in the building of a new Princeton, New Jersey housing development. The contractors had to drain a culvert and then build a bridge over it to complete one of the development roadways. Because there was a time limitation involved, it was evident that a pumping process, to clean out the culvert, would have to go on 24 hours a day in order to meet the deadline. The Cordflex suction hose was selected for the round-the-clock task of pumping out the slime and water to clear the way for building the new bridge. This hose was chosen because of its unusual ability to resist pressure, to stand abrasion, and because of its power and stamina for remaining on the job under difficult conditions. The Cordflex hose was made by Acme-Hamilton Mfg. Corp. of Trenton, New Jersey. One of the important materials used in the making of this hose is Mount Vernon duck.

This is another example of how fabrics made by Mount Vernon Mills, Inc. and the industries they serve, are serving America. Mount Vernon engineers and its laboratory facilities are available to help you in the development of any new fabric or in the application of those already available.

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SELLING AGENTS

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Branch Offices: Chicago • Atlanta • Baltimore • Boston • Los Angeles

Named by U.S. Rubber

► Leonard R. Fertig and Raymond J. Mucci have been appointed assistants to George R. Vila, president of U.S. Rubber Co., New York, N. Y. According to Mr. Vila, Mr. Fertig will coordinate management engineering activities and cost reduction programs, and Mr. Mucci will handle administrative functions of the president's office and special assignments.

Mr. Fertig majored in business finance at Western Reserve University and also attended Notre Dame University. He joined the firm's Footwear and General Products Division in 1942 as an office methods engineer at its Mishawaka, Ind., plant. In 1957, he was appointed control manager of sales and indirect manufacturing expenses for the division. The following year he became assistant to a group vice-president, the post he has held until his present appointment.

Mr. Mucci holds a B.S. degree in chemistry from the University of Connecticut and a master's degree in business administration from the Columbia University Graduate School of Business Administration. He joined the company's Naugatuck Chemical Division in 1952 as a research chemist. The following year he was assigned to market research and commercial development. In 1958, he was appointed to his previous post, assistant to the division's general manager.

Biltrite Buying Bonafide

► American Biltrite Rubber Co., Chelsea, Mass., has entered into an agreement to acquire the stock of Bonafide Mills, Inc., New York, N.Y. Bonafide manufactures vinyl asbestos and asphalt floor tile and linoleum. Maurice J. Bernstein, president of American Biltrite, said that no American Biltrite stock was involved, and did not disclose the purchase price. He stated that the acquisition was expected to add about $10 million to American Biltrite sales—which, in 1959, were $70,390,000—and add substantially to company earnings.

Bonafide Mills, with headquarters in New York City, operates plants in Trenton, N.J., and in Lisbon and Winthrop, Maine. According to Mr. Bernstein, the addition of vinyl asbestos and asphalt floor tile and linoleum to his firm's Amtico Flooring Division would round out a full line of company floor coverings. Bonafide Mills' plants will be operated as subsidiaries of American Biltrite.

M. L. Jeter

Named by C. P. Hall

► M. L. Jeter has been appointed by W. T. Hall, president of C. P. Hall Co., Akron, Ohio, as his administrative assistant. Mr. Jeter attended Akron University and the South Texas Law School, Houston, Texas. He had been associated with the Purchasing Department of Firestone Tire & Rubber Co., for 12 years, and recently returned to Akron from Indianapolis, Ind., where he served in a sales management capacity.

Flo-Tronics Acquisitions

► Flo-Tronics, Inc., Minneapolis, Minn., has announced the acquisition of Rubber Industries, Inc., Shakopee, Minn., and Plasticos Co., Minneapolis, through an exchange of stock, subject to approval by Flo-Tronics stockholders. Rubber Industries is a manufacturer of both black and colored rubber products for electronics and other industrial applications. The company will be a wholly-owned subsidiary, but will continue under the direction of its president, Donovan P. Stern. Business and production facilities of Plasticos will be integrated into Flo-Tronics' present Plastics Division under Sylvester Mady, vice-president and director of manufacturing for the division.

Cooper Names Manager

► Cooper Tire & Rubber Co., Findlay, Ohio, has named H. C. Heintzelman as sales manager for its Industrial Rubber Products Division. Mr. Heintzelman previously had been assistant sales manager for special products. He is a graduate of Case Institute of Technology with a B.S. degree in engineering administration. Prior to joining Cooper Tire in January, 1958, Mr. Heintzelman had been associated with Norbalt Rubber Corp. and Johnson Rubber Co.

LOOKING FOR A

COLD

Oil-extended SBR?

TRY 1712...

It's one of the best general-purpose cold, oil-extended polymers. Its balance of economy and good performance properties makes it ideal for such general-purpose applications as tires, tread rubber, molded and extruded mechanical goods.

Description:

Polymer	SYNPOL 1712
Emulsifier	Mixed Acid
Stabilizer	Staining
Coagulant	Salt Acid
Oil	HI-AR

TENTATIVE SPECIFICATIONS

Chemical:

Volatile Matter, % wt.	0.75 max.
Ash, % wt.	1.50 max.
Organic Acid, % wt.	3.90-5.70
Soap, % wt.	0.50 max.
Bound Styrene, % wt.	22.5-24.5
Stabilizer, % wt.	1.25 added

TYPICAL PRODUCTION VALUES

Physical:

Compound Viscosity, ML-4 @ 212°F.	46
Tensile Strength, 50' Cure @ 292°F, psi	3175
Elongation, 50' Cure @ 292°F, %	730
Modulus @ 300% Elongation, psi	
25' Cure @ 292°F	275
50' Cure @ 292°F	675
100' Cure @ 292°F	975

Test Recipe:

Polymer	100.00
EPC Black	40.00
Zinc Oxide	5.00
Sulfur	2.00
MBTS	2.00

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SYNPOL® SBR'S

Now you can greatly increase warehouse space at no increase in cost with...

AZODOX high apparent density zinc oxides

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- Stacks Higher, Safely
- Less Bag Breakage
- Close-Packed, Unitized Shipments

AZODOX stores in much less space than other zinc oxides. That's because you get many more pounds of AZODOX per cubic foot of pigment—up to 62 lbs. per cubic foot! Save valuable space for other purposes with every ton of AZODOX you buy.

In the manufacture of AZODOX, an exclusive process removes excess, space-wasting air from between individual particles of zinc oxide. Actual pigment density and every other desirable property remain unchanged. High apparent density AZODOX flows freely yet dusts less, incorporates fast and disperses thoroughly.

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☐ AZODOX-55 ☐ AZODOX-550
☐ 15 types of AZO brand zinc oxides

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Company.....
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AZODOX is available in the following grades at no additional cost over conventional zinc oxides:

	Bulk Density lbs./cu. ft.	Rate of Activation	Reinforcement Properties
AZODOX-44 (Conventional)	60	Medium	High
AZODOX-55 (Conventional)	60	Fast	High
AZODOX-55-TT (Surface Treated)	62	Fast	High
AZODOX-550 (Conventional)	58	Medium	High

American Zinc sales company

Distributors for
AMERICAN ZINC, LEAD AND SMELTING COMPANY
Columbus, Ohio • Chicago • St. Louis • New York

Harwick Names Three

► Harwick Standard Chemical Co., Akron, Ohio, has announced the appointment of C. J. Harwick, Jr. as general sales manager, while J. H. FitzGerald and J. L. Weaver have been appointed manager of the company's Boston, Mass., and Trenton, N. J., operations, respectively. Mr. Harwick, who attended Washington and Jefferson College and graduated from the University of Akron, joined the sales force of the company in June 1960. He has worked as a technical sales representative in both the Boston and Los Angeles branches of the company, and he recently became assistant sales manager at the home office.

A graduate of the Massachusetts Institute of Technology, Mr. FitzGerald was with the B. F. Goodrich Co., Akron, Ohio, prior to joining Harwick Standard in 1950. He has been a technical sales representative in the Boston area for the past ten years. Mr. Weaver is a graduate of Ohio State University. He joined the company in 1948 as a procurement expeditor, later becoming assistant treasurer and purchasing agent in the home office. In 1957 he became a sales representative for the Trenton branch.

C. J. Harwick, Jr.

Sue to Protect Tubing

► Rubber Latex Products Inc., and Harrison and Morton Laboratories Inc., both of Cuyahoga Falls, Ohio, have filed suit in Common Pleas Court to protect their processes for the manufacture of the rubber tubing through which blood transfusions are given. The defendants are Kent Latex Products Inc., Kent, Ohio; Ervin Ray Williams; and Judson C. Russell. Rubber Latex and Harrison and Morton have asked a court order against the use, by the Kent firm or others, of information gained by Mr. Williams and Mr. Russell through their former key posts with the companies. Mr. Williams was chief chemist for the laboratory firm, and Mr. Russell, plant and sales manager for the production end of the business. Both resigned their posts in the early summer and now are connected with the Kent operation, it is alleged.

Witco Acquires Firm

► Witco Chemical Co., New York, N. Y. has acquired Sonneborn Chemical and Refining Corp. and its subsidiaries in exchange for 300,000 shares of Witco stock. Sonneborn will function as an independently operated, wholly-owned subsidiary, and there will be no staff changes. Witco issued 300,000 new shares for the transaction.

N. Y. Christmas Party

► Over 400 members attended the Annual Christmas Party of the New York Rubber Group held on December 16, 1960, at the Henry Hudson Hotel in New York City. The program included a cocktail hour, dinner, entertainment, and awarding of Christmas prizes. After dinner, Ervin Kern (R. T. Vanderbilt), 1960 chairman, presented a Certificate of Merit to Robert B. Carroll (R. E. Carroll) for his service to the New York Rubber Group as chairman during 1959. M. E. Lerner (Rubber Age), 1960 secretary-treasurer, reported that the membership had overwhelmingly approved, via letter ballot, the establishment of a $500 per year scholarship at the University of Akron. After the entertainment, 129 prizes were distributed.

Develops Dye Technique

► Naugatuck Chemical Division, U. S. Rubber Co., Naugatuck, Conn., reports that it has developed a technique by which latex backings for fabrics can now be dyed the same color as the fabrics, with the same dyestuffs. According to the company, color acceptors are blended into standard latex compounds to modify the compounds so they will accept dyes. Naugatuck Chemical states that the color acceptors are now being blended into Lotol compounds at its Gastonia plant.

LOOKING FOR A

BLACK

Oil-extended Masterbatch?

TRY 8255...

It features 50-part oil extension for economy, plus a quality furnace black for good appearance and high abrasion resistance... teamed up for quality and service in such general-purpose applications as tires, tread rubber, hose, belting, and other mechanical goods.

Description:

Polymer	Type 8202
Emulsifier	Mixed Acid
Stabilizer	Staining
Coagulant	Acid
Oil	HI-AR
Carbon Black	HAF

TENTATIVE SPECIFICATIONS

Chemical:

Volatile Matter, % wt.	1.00 max.
Ash, % wt.	0.50 max.
Organic Acid, % wt.	3.25-4.75
Soap, % wt.	0.50 max.
Bound Styrene, % wt.	22.5-24.5
Stabilizer, % wt.	1.25 added
Carbon Black, % wt.	32-34.6

TYPICAL PRODUCTION VALUES

Physical:

Compound Viscosity, ML-4 @ 212°F	54
Tensile Strength, 50′ Cure @ 292°F, psi	2900
Elongation, 50′ Cure @ 292°F, %	620
Modulus @ 300% Elongation, psi	
25′ Cure @ 292°F	625
50′ Cure @ 292°F	1200
100′ Cure @ 292°F	1600

Test Recipe:

SYNPOL 8255	150.00
Zinc Oxide	5.00
Sulfur	2.00
MBTS	1.00

Yes we've got them all... over 30 distinct types of SYNPOL... one for practically every purpose. Hot, cold and cold oil-extended... light-colored, non-staining... commercially proved, ultra-dispersed, mechanically mixed masterbatches. You name it... we've got it.

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TEXUS Research Center: Parsippany, N. J.

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Vulcanized
vegetable oils rubber substitutes

Types, grades and blends for every purpose, wherever Vulcanized Vegetable Oils can be used in production of Rubber Goods — be they Synthetic, Natural, or Reclaimed.

A long established and proven product.

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Akron, Boston, Chicago,
Pico Rivera (Cal.), Trenton,
Albertville (Ala.), Denver,
Greenville (S. C.)

New Goods

Goodyear Idler Sleeve

► A new conveyor idler sleeve designed to improve cleaning action on belts during return trips has been developed by Goodyear Tire & Rubber Co., Akron, Ohio. The idler sleeves, using two treads rather than the single tread on conventional sleeves, flex the belt evenly as it passes over the idler rollers. The flexing action separates the caked accumulation from the belt

surface and causes it to flake off the belt. Called the Sta-Kleen Dubl-Tread, the sleeve has the ability to flex the belt surface into twice as many sections as a single tread, according to the company. Each sleeve has a channel between the two treads to receive a band that anchors the sleeve to the idler. The sleeves are fabricated of a two-ply duck foundation with treads built up to ½, ¾, or 1 inch wall thickness. The sleeves are built to the diameter of the idler roll to provide for easier application and longer life, the company states.

Pioneer Extra-Large Glove

► Pioneer Rubber Co., 296 Tiffin Road, Willard, Ohio, has added a new, extra-large size to its line of V-10 Nimble Fingers gloves. With the addition of the extra-large size, the V-10 Nimble Fingers' sheer hand protection is available for any hand—from small women's sizes to extra-large men's sizes, the company states. The new size retains all the features of the line: length of 10½ inches for ample wrist and lower arm protection; flare design of cuff opening for ventilation; textured inside finish for comfortable fit; and non-slip grip when worn reversed. According to the manufacturer, Nimble Fingers are resistant to the acids, alkalis, oils, greases and some solvents usually encountered in light hand work.

Straightaway Ear Protectors

► A new addition to the Straightaway line of ear protectors, manufactured by David Clark Co., Worcester, Mass., is a communications model No. 372-8BM. The lightweight, streamlined, tear drop mike shield encloses a noise cancelling, extended frequency microphone, activated by either a push-

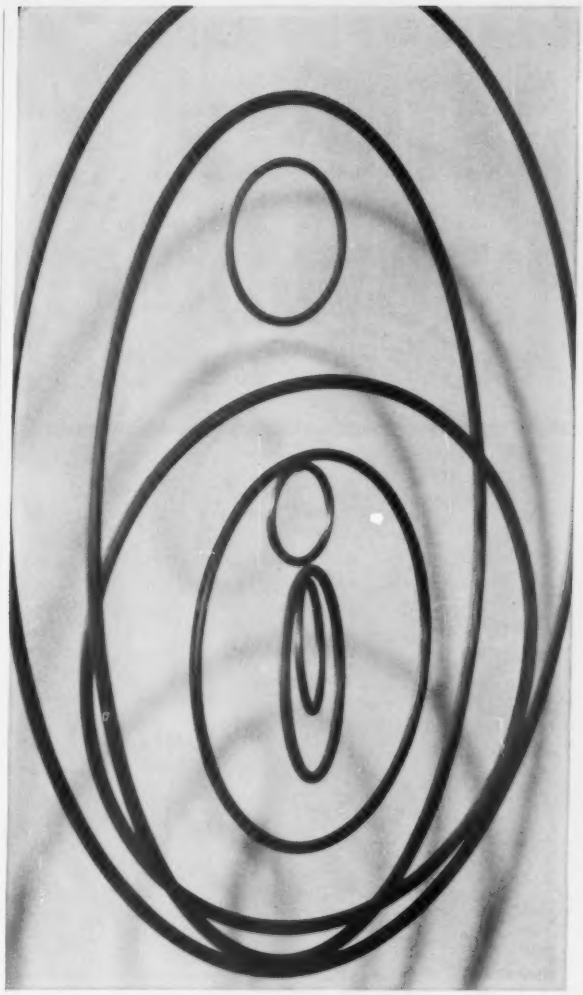
to-talk button or toggle switch located on the outside of the shield. Adjustable chin straps of nylon hold the shield in a comfortable position. Ear seals and microphone seals may be removed for easy cleaning, together with the head pad for replacement whenever necessary, the manufacturer states.

Pioneer Honey Hug Doll

► According to the manufacturer, Pioneer Rubber Co., Willard, Ohio, young and old alike can enjoy making their own embraceable doll with its new Qualatex Honey Hug. Available in an easy to assemble balloon kit, the Honey Hug comes complete with two black, imprinted head and body shaped Qualatex balloons, pink "grass" skirt, earrings, feet, and embraceable arms. The punch-out accessories and balloons are contained in an attractively printed, four-color, polyethylene covered pack.

Goodyear Tire Fuel Tanks

► A fleet of fuel-carrying tires almost as wide as they are high, has been developed for the U.S. Army by Goodyear Tire & Rubber Co., Akron, Ohio. The Rolling Liquid Transporters, modeled after Goodyear's Rolli-Tankers, have a capacity of 500 gallons. They can be towed, on land or in water, by virtually any vehicle and their unusual construction gives them low ground-bearing pressure on a wide contact area, allowing them to function in the most difficult off-the-road conditions.



WIRE-IN-RUBBER

. . . problem solved

In the photo above, you see many rings formed from steel wire. These are typical bead rings used in the manufacture of automatic air suspension systems for trucks, vibrating screens, etc.

National-Standard Company worked with the rubber companies, who manufacture such air-suspension systems, to develop equipment and forming methods that would meet critical tolerances. The result was low to high carbon rings (1¾" to 14" diameter) formed from flat or round wire sizes .041" to .185".

This is the kind of engineering help in solving wire-in-rubber problems that you get from National-Standard. Call us in on your next project.

NS **NATIONAL-STANDARD COMPANY**
Niles, Michigan

PUT PURECO'S

Deflashing "know-how"

TO WORK FOR YOU

Get the best from your tumbling installation

▶Pureco engineers daily improve the efficiency and economy of CO_2 deflashing operations. Configuration of parts, type and number of baffles, weight of charge, tumbling, additives, temperatures, R.P.M., length of tumbling cycle . . . all these variables affecting tumbling operations have been studied and operations improved in many cases. Pureco can help you enjoy the benefits of an efficient tumbling operation with Pureco CO_2 "Flash Chilling".

Pureco CO_2 "Flash Chilling" is economical

▶Cold temperature tumbling, using either solid (DRY-ICE) or CO_2 liquid as the refrigerant, when properly handled, provides the most satisfactory and economical means of productive deflashing.

Pureco engineers at your service

▶Whatever your deflashing problems, Pureco Technical Service will be happy to survey your operation, run demonstration tests and make recommendations with *no* obligation on your part.

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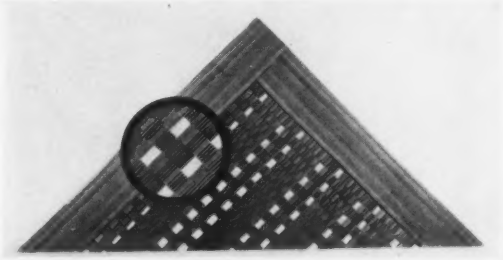
Musson Vinyl Link Mats

► The new Koroseal-Vinyl Link Mats, designed by R. C. Musson Rubber Co., Akron, Ohio, are said to have hundreds of clinging ribs built-in to eliminate slipping. Actual size of the openings between links is ¼ by ⅜ inches. Non-porous surfaces resist stains and discoloration, and the original attractiveness of the mats remains even after days and weeks of service without cleaning, the company reports. There is a storage capacity



between the links to trap large quantities of dirt which can be easily removed in off-peak times. The mats are offered sized to order, in solid colors, with or without contrasting color inside the border; or in special two-color design, or special field designs made to specifications. Colors are red, green, gray, blue, orange, yellow, brown, white, and black.

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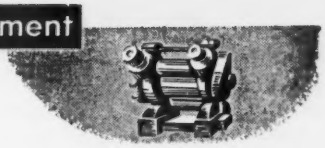
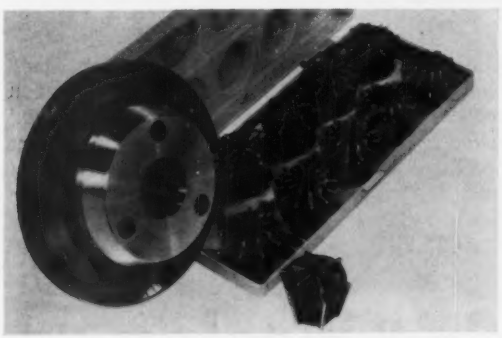


Jacobs Collet Chuck

► A collet chuck, known as Model 50, has been developed by Jacobs Manufacturing Co., West Hartford, Conn. The new chuck features the rubber-flex collet principle first used by the manufacturer on its Model 91 spindle nose lathe chuck. Each rubber-flex collet provides a range of .100 inches, 20 times that of one conventional split steel collet, and the gripping power and accuracy remain constant throughout the entire collet capacity. The complete set of 10 collets permits



the chucking of any bar between 3/32 and 1 1/16 inches. According to the manufacturer, the rubber-flex collets are comprised of hardened alloy steel jaws bonded together with a rubber compound based upon Hycar oil resistant type crude. This compound has been developed to meet rigid specifications for physical properties, particularly oil resistance, age resistance, and compression set. Other features of the Model 50 chuck are a nose-type closure and a one piece, high-impact handwheel featuring a phenolic molding with a steel insert.

Thwing-Albert Sample Cutter

► A new electro-hydraulically operated laboratory sample cutter has been developed by Thwing-Albert Instrument Co., Penn Street and Pulaski Avenue, Philadelphia 44, Penna. Called Model No. 240-4 Alfa Laboratory Sample Cutter, the unit is said to be more powerful than hand operated models. It is adjustable to apply up to 8 tons of pressure at the cutting surface. Effortless finger tip operation makes it possible to cut larger, thicker and harder laboratory samples of rubber, plastic, tissue, paper, paperboard, textiles, carpeting, etc. The manufacturer states that inexpensive Alfa sample dies make it possible to change from one size sample to another in a matter of seconds.

WIRE-IN-RUBBER

. . . problem solved

The polyethylene bead wire package shown above is another new development from National-Standard that permits more extended storage of bead wire without danger of rust or corrosion.

Extensive testing of the new package over many months in highly humid environmental chambers, without any evidence of wire corrosion, proved the new package superiority over old-style wrappers . . . means tire manufacturers can store bead wire for months without fear of damage.

The solution to this special wire-in-rubber problem is another National-Standard contribution to the rubber industry. Call National-Standard for help in solving your wire-in-rubber problems.

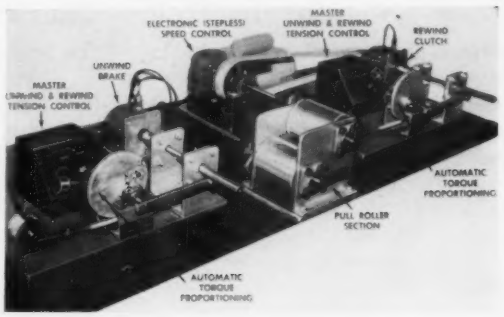
NS **NATIONAL-STANDARD COMPANY**
Niles, Michigan

Web Controls Width Process

► A new and versatile narrow width process and/or winding machine for any web or filament such as plastic, paper, metal and film, has been developed by Web Controls Corp., Dept. NW, 318 Briarcliffe Road, West Englewood, N. J. Said to be ideal for either laboratory or production set-ups, this machine is adaptable to any existing process such as curing, drying, printing, laminating, coating, sheeting, film-casting, etc. Identified as Model MARCO-1, the machine consists of three units: a constant tension unwind; a speed-controlled pull roller section; and a controlled tension winder. The unwind brake comes either coupled, geared or chained. The unwind may also be edge-controlled, equipped with a web-centering assembly, or controlled program oscillation assembly. All three units of the machine may be mounted in various positions — horizontally or vertically. The winder section is equipped with an automatic torque proportioning device which, according to the manufacturer, makes it possible to produce tapered tensions of practically any characteristic such as linear, parabolic, hyperbolic or any function of the diameter build-up.

Metron Angle and T-Drive

► Metron angle and T-drives, designated Series 12, are said to offer designers many advantages where power must be reliably transmitted at right angles in cramped space. Manufactured by Metron Instrument Co., 432 Lincoln St., Denver 3,



Colo., these 1:1 ratio units may be integrally combined with any of the firm's miniature speed reducers, or between two or more of these speed reducers, thus permitting takeoffs with different speed reductions. Drives handle up to 24 ounce/inch of torque, and speeds to 10,000 rpm are reached without excessive wear. Maximum power is 0.025 hp.

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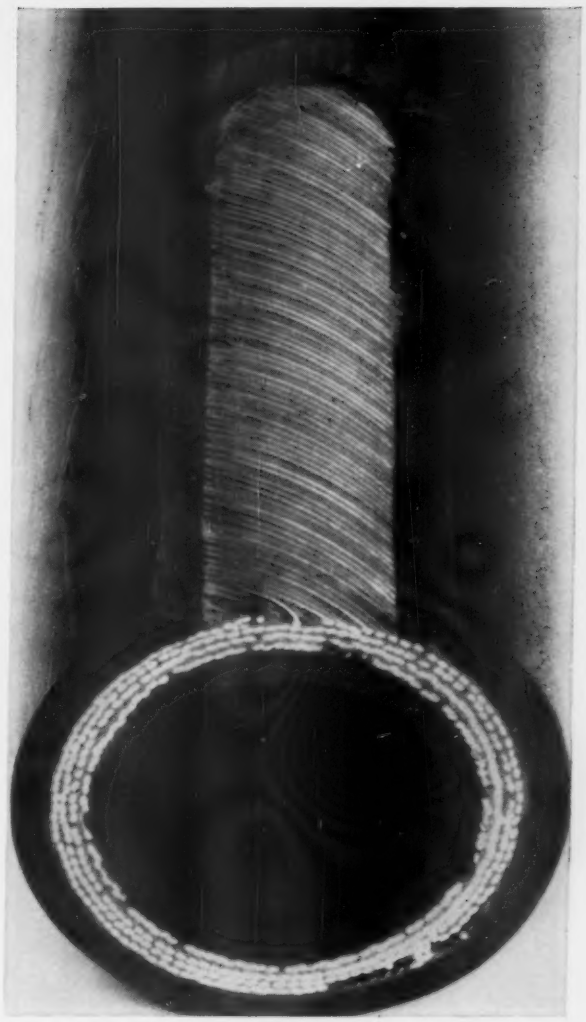
Farrel-Birmingham Calender

► Farrel-Birmingham Co., Inc., Ansonia, Conn., has installed in its process laboratory a new 8 by 16 inch, four-roll, inclined "Z" calender which is expected to provide more exact test results in a complete range of operations than has been possible with any single laboratory calender. The new calender features individual, adjustable-voltage, direct current drive for each of its four rolls. This is said to provide stepless variation in roll speeds in the wide range of 6 to 48 feet per minute, any required friction ratio being easily obtainable for any roll pair. According to the company, this drive flexibility, the advantage of the

inclined "Z" roll arrangement, and an operating temperature range up to 500°F., all ideally suit this machine for such calendering operations as: unsupported film or sheeting; unsupported double film or sheeting; single coat on carrier; double coat on carrier; and single frictioning. The company reports that, within a booking schedule which allows for confidential experimentation, the use of all facilities of the laboratory are available without charge or obligation, up to two full days within one year, to rubber and plastics manufacturers who wish to conduct tests with new materials or evaluate new processing techniques. Arrangements can also be made for more extended periods of use on a fee basis.

Dillon Dyna-Switch

► Developed by W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif., this latest addition to the firm's line is said to offer complete protection against accidental overloading of hoists and cranes. The Dyna-Switch now has its sensitive control switches housed in a heavy metal junction box, sealing out rain, dirt, moisture, and dust. The housing also accommodates spliced cable ends which are fed into this box through spring suspension cable fittings with locking collars. When a crane attempts to lift a load that is over the predetermined danger point, the Dillon Dyna-Switch shuts off the current.



WIRE-IN-RUBBER

. . . problem solved

The ¾" high-pressure hose shown above has a 4-spiral wrap of high-tensile .012" liquor finish, high-carbon steel wire. This spiral wrap design is a new development by hose engineers that provides good fatigue qualities and high bursting strength for such critical applications as jet-aircraft hydraulic systems. The N-S special liquor finish on the wire provides better wire-to-rubber adhesion than old standard liquor finishes. The solution to this special wire-in-rubber problem is another National-Standard contribution to the rubber industry. Call National-Standard for help in solving your wire-in-rubber problems.

NS **NATIONAL-STANDARD COMPANY**
Niles, Michigan

Until the introduction of Amberex, another type of Factice®, white Factice® was the only vulcanized vegetable oil which could be used in light-colored goods, such as those shown above, where good calendering properties and smooth stock are essential.

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Factice Vulcanized Oil

THE STAMFORD RUBBER SUPPLY CO.
STAMFORD, CONN.

Reviews

Punched Cards: Their Application to Science and Industry (Second Edition). Edited by R. S. Casey, J. W. Perry, A. Kent and M. Berry. Published by Reinhold Publishing Corp., 430 Park Avenue, New York 22, N. Y. 6 x 9¼ in. 697 pp. $15.00.

Thoroughly revised and enlarged, this second edition surpasses its predecessor in describing clearly every aspect of punched card systems. All who handle large masses of data will find here the principles and methods which apply to small files or the largest, and descriptions of the entire range of cards and equipment now available. This is the only volume including both hand- and machine-sorted cards. It serves as an elementary instruction manual as well as an advanced handbook.

In addition to the mechanical techniques of punched cards and related devices, the book also shows how to find, arrange, use, store and retrieve information of any kind. Such considerations are a prerequisite to any system, and they can be applied to a simple collection of data in notebooks, on plain cards, in correspondence files, and finally to data handling by punched cards and electronic computers.

The introductory material contains sufficient information to permit an individual to set up and use a simple punched-card file. The heart of the book consists of case histories of applications, carefully selected to show what has already been accomplished. A theoretical section discusses fundamental problems in organizing information quite apart from punched-card techniques. Another section speculates on the role that punched cards and related devices may eventually play in relation to other methods. Finally, a very useful bibliography is presented on uses of punched cards in connection with scientific information.

•

Organic Reactions: Volume XI. Arthur C. Cope, editor-in-chief. Published by John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y. 6 x 9¼ in. 501 pp. $12.00.

The format of this volume is similar to its predecessors. Each chapter critically surveys a particular reaction, and contains a general discussion of method, modifications, examples of applicability, special precautions, a detailed description of the procedure, expected yields, and other pertinent data.

In keeping with the purpose of this series, Volume XI presents several important synthetic organic chemical reactions that are frequently used in research. These include: "The Beckmann Rearrangement," "The Demjanov and Tiffeneau-Demjanov Ring Expansions," "Arylation of Unsaturated Compounds by Diazonium Salts," "The Favorskii Rearrangement of Haloketones," and "Olefins from Amines: The Hofmann Elimination Reaction and Amine Oxide Pyrolysis."

Tables have been compiled for each chapter, listing compounds which have been prepared by—or subjected to—the reaction under discussion in that chapter. Bibliographies are also given to guide the investigator in his search of the literature. Incidentally, the first volume in this series was published in 1942 and Volume X was published in 1959. This book brings to the Organic Reactions series a new editor-in-chief, Arthur Cope, replacing Roger Adams who had held this position since 1942. Dr. Cope has been Professor of Organic Chemistry and head of the Chemistry Department at the Massachusetts Institute of Technology for the past fifteen years. He received the A.C.S. Award in Pure Chemistry for his discovery of the "Cope rearrangement."

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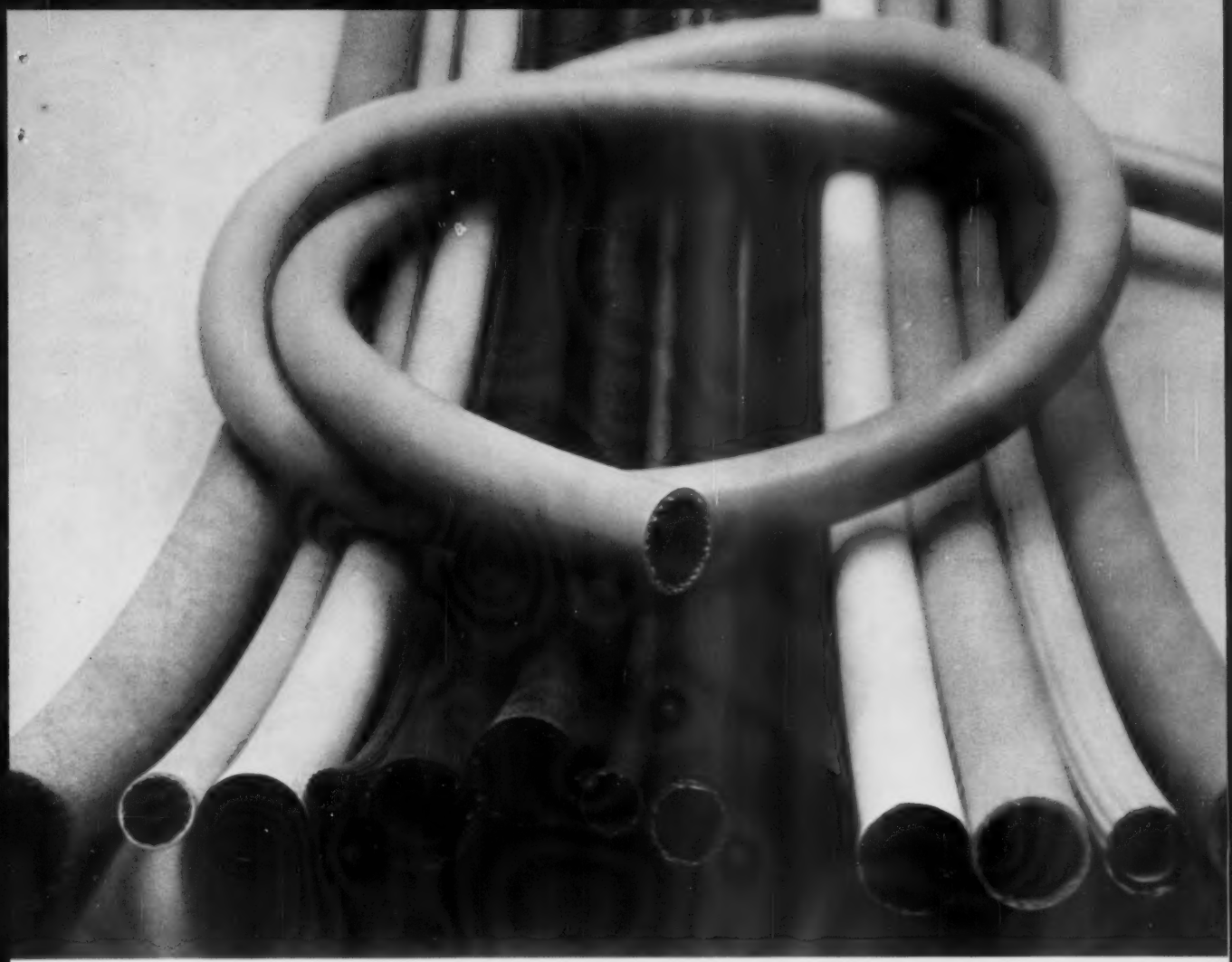

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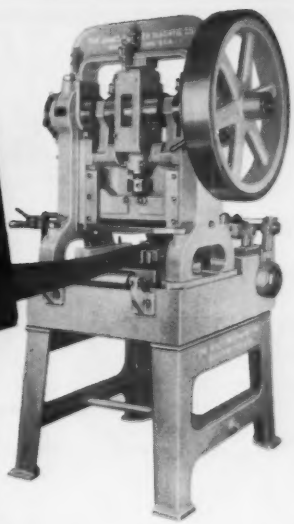

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BOOKLETS, CATALOGS, etc.

Regulators and Manifolds. (Form 55-085). Linde Co., 270 Park Avenue, New York 17, N. Y. 8½ x 11 in. 16 pp.

Oxweld industrial gas regulators and portable manifolds are described and illustrated in this comprehensive catalog. Included are complete specifications and ordering information for regulators that are available for use with all industrial gases, and completely portable manifolds for use with oxygen and acetylene. Inlet and outlet connections are listed according to the American Standards of the Compressed Gas Association. Recommended uses and installations are included in the description of each regulator. In addition to covering single- and two-stage regulators for station and manifold service, the catalog also describes a new line of single-stage regulators without gages and regulator manifolds for use in late model pre-mix beverage dispensing machines.

•

Outstanding Service in Rubber Compounding and Molding. (Bulletin C-60.) Colonial Rubber Co., Ravenna, Ohio. 8½ x 11 in. 16 pp.

This colorfully illustrated brochure describes a rubber company's products and services, including an extensive research operation available to processors. Most of the promotional piece deals with natural and synthetic rubber molds for industrial components. Another section reviews the physical properties of different formulations of a silicone rubber compound being distributed for custom compounding and molding, as well as in sheet form for die cutting and fabricating.

Acrylonitrile. Plastics Division, Department 741, Monsanto Chemical Co., Springfield 2, Mass. 8½ x 11 in. 16 pp.

The properties, uses, handling and testing of acrylonitrile are described in this recently published booklet. A special chart showing the extensive reactions and derivatives resulting from organic syntheses of acrylonitrile is included as part of the report. The chart is divided into cyanoethylation, nitrile, and olefinic reactions and lists the broad range of potential uses for acrylonitrile derivatives. Other sections of the booklet are devoted to the proper storage and handling of acrylonitrile and its end-use applications. The booklet also highlights results of ultraviolet spectroscope quality control tests and discusses other analytical techniques employed by Monsanto to ensure uniform quality and purity of its acrylonitrile.

•

The Story of Prices. Public Relations Department, E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del. 8¾ x 11¾ in. 32 pp.

The illustrated booklet describes the price structure as "an inseparable part of the American economy, an economy that is at once consumer controlled and consumer centered," and shows how the price structure evolved to meet the growing and changing needs of the American people. According to the booklet, throughout history every society has been concerned with price structure, and has sought to maintain some controls over it. "Only in the past 150 years, in free nations such as the United States," the booklet states, "has man been able to develop an economic system which liberates him from arbitrary action in the price area, and which provides the means to fill his many and diverse needs."

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Bonding Silicone Rubber. (CDS-245). Silicone Products Dept., General Electric Co., Waterford, N. Y. 8½ x 11 in. 4 pp.

Entitled "How to Bond Silicone Rubber," the new publication reviews the existing bonding technology and presents some of the latest advances and new techniques which help eliminate the more difficult bonding problems. The material breaks the subject down into five practical categories of bonding problems including: (1) bonding cured silicone rubber to cured silicone rubber; (2) bonding cured silicone rubber to metal; (3) bonding cured silicone rubber to plastic; (4) bonding uncured silicone rubber to cured silicone rubber; and (5) bonding uncured silicone rubber to metal. Fully illustrated, the publication also includes data on typical bond strengths of silicone rubber under a variety of conditions.

•

Attrition Mills. (Bulletin A-560-A). Robinson Division, Young Machinery Co., Inc., Muncy, Penna. 8½ x 11 in. 8 pp.

Robinson single and double runner attrition mills are discussed in this illustrated technical catalog. The literature covers motor and belt driven double runner mills, Frigidisc single runner water cooled mills, Attritor pressure-fed single runner mills, as well as the complete line of Junior Disc single runner mills for laboratory, pilot plant and small capacity operations. Complete dimensions, weights and capacity specifications are given, in addition to details on feeding mechanisms, drives, design features and specific applications. Attrition mill plates are also illustrated and described.

Ethers. Union Carbide Chemicals Co., 270 Park Ave., New York 17, N. Y. 8½ x 11 in. 44 pp.

The properties and uses of ethers and glycol diethers are described. The booklet contains comprehensive data on ethyl ether, isopropyl ether, butyl ether, and 1,4-dioxane and the glycol diethers; diethyl Carbitol, dibutyl Carbitol, and methyl ethyl Carbitol. Included is information on physical properties; solubilities; constant-boiling mixtures; specification limits; test methods; storage, handling, and shipping; physiological properties; and selected literature references.

•

Machinery for Plastics. Modern Plastic Machinery Corp., 64 Lakeview Ave., Clifton, N. J.

The folder is a product line bulletin which illustrates and describes plastic extruders, casting roll units, take up equipment, and accessories. Product specifications and features are shown for extruders ranging from 1 inch laboratory models up to 6 inch diameter production extruders. Other items include combination overhead pinch roll and take up units for blown tubular film, the firm's sheeting line, and packaged monofilament equipment. Also listed are the company's domestic and foreign sales representatives.

•

Extrusion Coating Today. (MS. No. 2042). Union Carbide Plastics Co., 30 East 42nd St., New York 17, N. Y. 8½ x 11 in. 8 pp.

A review of current developments in polyethylene extrusion coating presented by F. R. Tittman of Union Carbide Plastics Co. at a recent Cleveland, Ohio, meeting of the American Chemical Society, is the subject of this booklet. New resin compounds, fabricating innovations and future markets are discussed.

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MARKET REPORTS

TRENDS
NEWS
PRICES

Natural Rubber

The price of natural rubber on the New York Commodity Exchange moved in a range of 75 points since our last report (December 1), high for the period being 29.13c reached on December 20, and low being 28.38c reached on December 15. The average price of spot rubber in December was 28.81c based on 21 trading days. This compares with an average of 30.63c in November.

H. C. Bugbee, president of the Natural Rubber Bureau, recently pointed out that natural rubber as a commodity is currently in the era of competition that has been on the horizon since the stereo rubbers first came into the picture some five or six years ago. It is estimated that some 3,780,000 tons of all types of new rubber will be consumed during 1960, and, by 1965, industry economists forecast consumption of approximately 4,500,000 tons.

According to Mr. Bugbee, Malaya's natural rubber industry is today concentrating on raising production so as to be able to account for its share of this over-all growth in demand. In 1960, a total of some 2,025,000 tons of natural rubber was produced by the entire growing industry. By 1970, it will be producing some 2,810,000 tons. In 1960, Malaya accounted for the largest share of the year's production with some 715,000 tons; Malaya's contribution in 1970 is forecast at some 1,200,000 tons.

Consumption Statistics

The U.S. Department of Commerce reports that natural rubber consumption in the United States in November was 35,915 long tons, compared with the October total of 37,033 tons. For the first eleven months of 1960, consumption of natural rubber amounted to 447,657 tons, and for the same period in 1959, consumption was 512,094 tons. Natural rubber stocks, as of November 30, were 71,920 tons, a decline from 76,166 tons on October 31.

The Rubber Manufacturers Association estimates that the total United States rubber consumption in 1960 was 1,560,000 long tons, of which 483,000 tons was natural rubber. This compares with 1,627,770 and 555,044 tons, respectively, in 1959. For 1961, estimated consumption is 1,600,000 long tons, with natural rubber accounting for 450,000 tons.

Rubber Markets Steady

It is rather difficult to pinpoint the reason for the prevailing steadiness in the natural rubber markets and in particular in Singapore. The main factor is undoubtedly the recent sales to China which all have to be shipped from Singapore, as China still refuses to buy shipments from Malaya.

NEW YORK, JANUARY 3, 1961

Price Data

Closing Rubber Prices on New York Commodity Exchange

FROM DEC. 1 TO DEC. 31

Dec.	Spot	Jan.	Mar.	May	Sales
1	28.50	28.50	28.52	28.60	64
2	28.63	28.50	28.65	28.65	19
3	....	....	....	....	..
4	....	....	....	....	..
5	28.75	28.65	28.75	28.75	5
6	28.63	28.51	28.60	28.65	11
7	29.00	29.07	29.07	29.10	76
8	29.00	29.10	29.10	29.10	24
9	28.88	28.80	28.90	28.95	33
10	....	....	....	....	..
11	....	....	....	....	..
12	28.88	28.75	28.75	28.80	2
13	28.88	28.85	28.85	28.90	10
14	28.50	28.40	28.41	28.51	74
15	28.38	28.26	28.45	28.50	38
16	28.63	28.40	28.60	28.75	21
17	....	....	....	....	..
18	....	....	....	....	..
19	28.75	28.60	28.80	28.90	4
20	29.13	29.05	29.10	29.25	75
21	28.88	28.65	28.75	28.80	19
22	28.88	28.65	28.70	28.75	56
23	28.88	28.65	28.85	28.95	12
24	....	....	....	....	..
25	....	....	....	....	..
26	....	....	....	....	..
27	29.00	28.80	28.85	29.05	9
28	28.88	28.65	28.85	28.90	34
29	28.88	28.75	28.95	29.10	131
30	29.00	28.89	28.90	29.00	22
31	....	....	....	....	..

Outside Market

No. 1 Ribbed Smoked Sheets:	
Spot	.28⅞
Jan.	.29
Feb.	.29
Thin Latex Crepe:	
Spot	.30⅞
Thin Brown Crepe, No. 2	.26
Flat Bark Crepe	.21

London Market
(Standard Smoked Sheets)

Feb.	29.94 — 30.09
Apr.-June	29.95 — 30.09

Singapore Market
(Standard Smoked Sheets)

Feb.	28.09 — 28.21

Middling Upland Quotations

	Nov. 30	Dec. 30		
	Close	High	Low	Close
Mar.	32.10	32.14	32.12	32.12
May	32.53	32.61	32.60	32.61
July	33.03	33.08	33.01	33.01

Notes & Quotes

There are certain areas where natural rubber, or synthetic-natural, cannot be replaced by other types of presently known synthetics, said J. Ward Keener, president of the B. F. Goodrich Co. In other areas, synthetic rubbers are much preferred. "Somewhere in the middle, an area comprising perhaps 30 per cent of the consumption of new rubber in the United States, price is the determining factor between the selection of natural and synthetic rubber."

Synthetic Rubber

When the General Tire & Rubber Co. won a patent, after a ten year battle in the courts, for the High-Mooney oil-extended rubber process used in making tires, they requested other tire manufacturers to pay a royalty on the process.

In a four page letter sent to 18 tire manufacturers, General Tire is said to be asking a minimum royalty of $2,000 a year. The royalty would amount to ⅜ cents a pound or about four cents a passenger car tire.

The royalties would carry an escalator clause geared to the price of synthetic rubber. If synthetic rubber rises or falls more than 10 per cent in price, the royalties would be adjusted accordingly.

Royalties on the process could amount to $3.9 million annually if General Tire should succeed in licensing all other users, based on the company's estimate. In addition to the royalties, General Tire is asking an initial fee of $2,000 for a license.

Oil extended synthetic rubber is used widely in the industry for tires and other products. The patent was first applied for on November 20, 1950, but was denied.

Judge Alexander Holtzoff of the U.S. District Court of Washington, D.C., in his decision, overruled the U.S. Patent Office Board of Appeals. The patent applies only to the tire-making process and not to other products which are made from oil-extended rubber.

General Tire President M. G. O'Neal estimated that during 1959 at least 75 per cent of the total oil-extended rubber produced went into tire treads.

Tires Use Five Synthetics

Speaking before the Economic Club of Detroit, H. E. Humphreys Jr., chairman of the U.S. Rubber Co. said: "Until three years ago we used only three basic types of rubber in tires—natural and two synthetics. Today we use natural and five synthetics, one of which is an exact duplicate of natural rubber. And there are just as many more new materials around the corner."

In discussing tires, Mr. Humphreys said the next big advance will be the two-ply tire, and "we're already looking ahead to a tire with only one ply." He explained that lighter weight, cooler running tires are made possible as stronger materials are developed.

Another international step forward was made by the Goodyear Tire & Rubber Co. when it opened a $7,000,000 facility in France. Located 80 miles north of Paris on the Somme River, the plant will produce auto, truck and farm tires and tubes for original equipment, replacement and export markets. French finance minister M. Jeanneney and Goodyear board chairman E. J. Thomas presided at the opening.

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Basic Carbonate of White Lead	Red Lead (95%-97%-98%)
Sublimed White Lead	Sublimed Blue Lead

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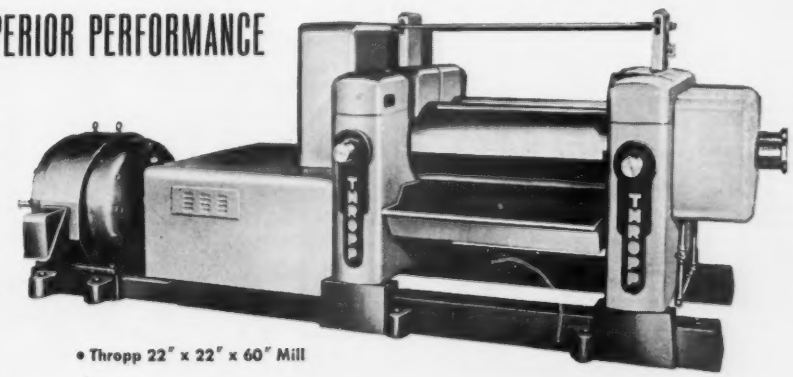

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Dry Rubber

(per pound carload)

Butadiene-Acrylonitrile Types

Butaprene NF	.4900
Butaprene NH	.6500
Butaprene NL	.5000
Butaprene NXM	.5800
Chemigum N3NS and N5	.5800
Chemigum N6	.5000
Chemigum N6B	.5000
Chemigum N7	.5000
Chemigum N8	.5000
Chemigum N600	.5000
Herecol N-33	.6800
Hycar 1001 and 1041	.5800
Hycar 1002	.5000
Hycar 1014	.6000
Hycar 1042 and 1043	.5000
Hycar 1051	.5800
Hycar 1052	.5000
Hycar 1053	.5000
Hycar 1072	.6400
Hycar 1203	.4600
Hycar 1312	.5000
Hycar 1411	.6200
Hycar 1432	.5900
Hycar 1441	.6200
Paracril AJ	.4850
Paracril B and BJ	.5000
Paracril BLT and BJLT	.5000
Paracril C and CLT	.5800
Paracril CV	.6300
Paracril D	.6500
Paracril 18-80	.6000
Paracril OZO	.4600
Polysar Krynac 800	.5000
Polysar Krynac 801	.5800
Polysar Krynac 802	.5000
Polysar Krynac 803	.5000

Butadiene-Styrene Types

Ameripol 1000	.2410
Ameripol 1001	.2410
Ameripol 1002	.2435
Ameripol 1006	.2410
Ameripol 1006 (crumb)	.2475
Ameripol 1007	.2410
Ameripol 1009	.2475
Ameripol 1009 (crumb)	.2590
Ameripol 1011	.2475
Ameripol 1012	.2425
Ameripol 1012 (crumb)	.2490
Ameripol 1013	.2410
Ameripol 1013 (crumb)	.2615
Ameripol 1500 and 1501	.2410
Ameripol 1502	.2410
Ameripol 1605	.1900
Ameripol 1703	.2060
Ameripol 1705	.2035
Ameripol 1707	.1910
Ameripol 1708	.1910
Ameripol 1710	.1885
Ameripol 1712	.1885
Ameripol 1805	.1550
Ameripol 1808	.1480
Ameripol 1809	.1545
Ameripol 1810	.1400
Ameripol 4600	.2410
Ameripol 4601	.2410
Ameripol 4651	.1770
Ameripol 4659	.1820
Ameripol 4660	.1870
Ameripol 4664	.1845
Ameripol 4667	.2080
Ameripol 4700	.1750
Ameripol 4756	.1545
Ameripol 4758	.1450
Ameripol 4759	.1598
Ameripol 4760	.1576
Ameripol 4761	.1710
ASRC 1000	.2410
ASRC 1001 and 1004	.2410
ASRC 1006	.2410
ASRC 1009	.2475
ASRC 1018	.2700
ASRC 1019	.2650
ASRC 1500	.2410
ASRC 1502	.2410
ASRC 1503	.2625
ASRC 1703	.2060
ASRC 1708	.1910
ASRC 1712	.1885
ASRC 1713	.1750
ASRC 3105 and 3106	.2410
ASRC 3110	.2600
Baytown B-129	.1960
Baytown B-134	.1900
Baytown B-172	.1825
Baytown 1600	.1930
Baytown 1601	.1930
Baytown 1602	.1930
Baytown 1801	.1760
Baytown 1803	.1740
Baytown 1811	.1569
Baytown 8675	.1820
Baytown 8676	.1876
Baytown 8677	.1820
Baytown 8678	.2080
Baytown 8679	.2022
Baytown 8680	.1775
Baytown 8681	.1835
Baytown 8775	.1545
Baytown 8776	.1679
Baytown 8777	.1550
Baytown 8778	.1480
Baytown 8779	.1496
Baytown 8780	.1507
Baytown 8781	.1655
Baytown 8782	.1583
Baytown 8783	.1515
C-102 (Shell)	.2300
Carbomix 3750	.1820
Carbomix 3751	.1545
Carbomix 3752	.1845
Carbomix 3753	.1640
Carbomix 3756	.1569
Carbomix 3757	.1480
Carbomix 3758	.1545
Carbomix 3760	.1496
CB-102 (Shell)	.1850
Copo 1006	.2410
Copo 1500	.2410
Copo 1502	.2410
Copo 1505-NS	.2610
Copo 1507	.2410
Copo 1510	.2410
Copo 1712	.1885
Copo 1713	.1750
Copo 1714	.1725
Copo 1773	.2060
Copo 1778	.1910
Copo 2000	.2775
Copo 3700	.1725
Copo 3701	.1750
Copo 3900	.2310
FR-S 146	.2410
FR-S 158	.3000
FR-S 173	.2060
FR-S 178	.1910
FR-S 181 and 182	.2410
FR-S 184	.1885
FR-S 1000	.2410
FR-S 1001	1410
FR-S 1004 and 1006	.2410
FR-S 1007	.2410
FR-S 1009	.2475
FR-S 1010	.2600
FR-S 1012	.2425
FR-S 1013	.2410
FR-S 1014	.2810
FR-S 1500 and 1502	.2410
FR-S 1703	.2060
FR-S 1710 and 1712	.1885
Gentro 1500	.2410
Gentro 1712	.1885
Gentro-Jet 9152	.2080
Gentro-Jet 9153	.1820
Gentro-Jet 9154	.1845
Gentro-Jet 9250	.1580
Gentro-Jet 9251	.1640
Gentro-Jet 9252	.1670
Gentro-Jet 9275	.1500
Naugapol 1016	.2650
Naugapol 1018	.2700
Naugapol 1019	.2650
Naugapol 1022	.3050
Naugapol 1023	.3300
Naugapol 1503	.2625
Naugapol 1504	.0330
Naugapol 6003	.2700
Naugapol 6100	.3200
OB-102 (Shell)	.1825
OB-104 (Shell)	.1475
OB-106 (Shell)	.1510
OB-110 (Shell)	.1410
OB-111 (Shell)	.1540
OB-113C (Shell)	.1750
OB-114C (Shell)	.1420
OB-116 (Shell)	.1810
Philprene 1000	.2410
Philprene 1006	.2410
Philprene 1009	.2475
Philprene 1018	.2700
Philprene 1019	.2650
Philprene 1500 and 1502	.2410
Philprene 1503	.2625
Philprene 1601	.1930
Philprene 1603	.1960
Philprene 1605	.1900
Philprene 1606	.1820
Philprene 1608	.1845
Philprene 1609	.2080
Philprene 1703	.2060
Philprene 1708	.1910
Philprene 1712	.1885
Philprene 1803	.1740
Philprene 1805	.1550
Philprene 1808	.1480
Plioflex 1006	.2410
Plioflex 1500C	.2410
Plioflex 1502	.2410
Plioflex 1507	.2410
Plioflex 1508	.2410
Plioflex 1510	.2410
Plioflex 1710C and 1712C	.1885
Plioflex 1713	.1750
Plioflex 1714C	.1725
Plioflex 1773	.2060
Plioflex 1778	.1910
Polysar Kryflex 200	.2510
Polysar Krylene	.2410
Polysar Krylene NS	.2410
Polysar Krynol 651	.1885
Polysar Krynol 652	.1910
Polysar S-630	.2410
Polysar S-X 371	.2550
Polysar SS-250	.2875
S-1000	.2300
S-1002	.2325
S-1006	.2300
S-1009	.2400
S-1011	.2325
S-1013	.2300
S-1500	.2300
S-1502	.2300
S-1509	.2300
S-1600	.1825
S-1602	.1825
S-1604	.1825
S-1605	.1800
S-1606	.1750
S-1607	.1750
S-1703	.1950
S-1707	.1800
S-1709	.1775
S-1710	.1775
S-1712	.1775
S-1778	.1800
S-1800	.1475
S-1802	.1410
S-1803	.1650
S-1804	.1750
S-1806	.1510
S-1807	.1540
S-1808	.1420
S-7652	.1875
S-7701	.1850
SP-103 (Shell)	.2900
Synpol 1000 and 1001	.2410
Synpol 1002	.2435
Synpol 1006	.2410
Synpol 1007	.2410
Synpol 1009	.2475
Synpol 1012	.2425
Synpol 1013	.2410
Synpol 1061	.2410
Synpol 1500	.2410
Synpol 1502	.2410
Synpol 1551	.2410
Synpol 1703	.2060
Synpol 1707	.1910
Synpol 1708	.1910
Synpol 1712	.1885
Synpol 8103	.2401
Synpol 8151	.1820
Synpol 8152	.1860
Synpol 8200	.1910
Synpol 8201	.1750
Synpol 8202	.1725
Synpol 8208	.1750
Synpol 8255	.1480
Synpol 8253	.1584
Synpol 8254	.1545
Synpol 8266	.1598
Synpol 8267	.1640

Butyl Rubbers

Enjay Butyl 035 and 150	.2300
Enjay Butyl 165 NS	.2400
Enjay Butyl 215	.2300
Enjay Butyl 217	.2300
Enjay Butyl 218	.2300
Enjay Butyl 268 NS	.2400
Enjay Butyl 325	.2300
Enjay Butyl 365 NS	.2400
Polysar Butyl 100	.2450
Polysar Butyl 101	.2775
Polysar Butyl 200 and 300	.2450
Polysar Butyl 301	.2550
Polysar Butyl 400	.2450

SYNTHETIC RUBBER POLYMERS

Chlorosulfonated Polyethylene

Hypalon 20	.4700 [2]
Hypalon 30	.6000 [2]
Hypalon 40	.5000 [2]

Fluoroelastomers

Fluorel	$10.25 [2]
Kel-F 3700 and 5500	$16.00 [2]
Viton A and A-HV	$10.00 [2]
Viton B	$13.00 [2]

Neoprene

	(prices l.c.l.)
Neoprene Types AC and CG	.5500 [3]
Neoprene Type AD	.5500 [3]
Neoprene Type FB	.6500 [3]
Neoprene Type GN	.4100 [3]
Neoprene Type GN-A	.4100 [3]
Neoprene Type GRT	.4200 [3]
Neoprene Type KNR	.7500 [3]
Neoprene Type S	.4200 [3]
Neoprene Type W	.3900 [3]
Neoprene Type WB	.4100 [3]
Neoprene Type WHV	.3900 [3]
Neoprene Type WRT	.4500 [3]
Neoprene Type WX	.4100 [3]

Polysulfide Rubbers

	(prices l.c.l.)
Thiokol Type A	.5000 [3]
Thiokol Type FA	.6900 [3]
Thiokol Type ST	1.2500 [3]

Silicone Rubbers*

	(prices l.c.l.)
GE (compounded)	2.50 [3]
GE Silicone Gum (not compounded)	4.00 [3]
Silastic (compounded)	2.50 [3]
Silastic (gums)	4.00 [3]
Union Carbide (gums)	4.00 [3]
Union Carbide (compounds)	2.50 [3]

Latex

(per pound carload)

Butadiene-Acrylonitrile Types

Butaprene N-300	.4600 [1]
Butaprene N-400 and N-401	.5400 [1]
Chemigum 200	.4800 [3]
Chemigum 235	.5300 [3]
Chemigum 236	.5300 [3]
Chemigum 245	.4500 [3]
Chemigum 246	.4500 [3]
Chemigum 247	.4500 [3]
Chemigum 248	.4500 [3]
Hycar 1312	.4500 [3]
Hycar 1551	.5300 [3]
Hycar 1552	.4500 [3]
Hycar 1561	.5300 [3]
Hycar 1562	.4500 [3]
Hycar 1571	.5300 [3]
Hycar 1572	.4500 [3]
Hycar 1577	.4500 [3]
Nitrex 2612	.4500 [1]
Nitrex 2616	.5300 [1]
Nitrex 2620	.4500 [1]
Nitrex 2625	.4500 [1]
Tylac 640 and 650	.4500 [1]
Tylac 750	.4900 [1]
Tylac 850	.5300 [1]
Tylac 1640 and 1650	.5400 [1]

Butadiene-Styrene Types

CL-101 (Shell)	.2800 [3]
Copo 2000	.2775 [3]
Copo 2101	.3000 [3]
Copo 2102	.3200 [3]
Copo 2105	.3200 [3]
Copo 2108	.3000 [3]
Copo 2109	.2775 [3]
Copo 2110	.3200 [3]
Copo 3852	.3000 [3]
FR-S 110	.3000 [3]
FR-S 150	.3000 [3]
FR-S 151	.2900 [3]
FR-S 174	.2950 [3]
FR-S 176	.2775 [3]
FR-S 2000	.2775 [3]
FR-S 2001	.2775 [3]
FR-S 2002	.3000 [3]
FR-S 2003	.3050 [3]
FR-S 2004	.3050 [3]
FR-S 2006	.2900 [3]
FR-S 2105	.3300 [3]
Naugatex 2000 and 2001	.2750 [1]
Naugatex 2002	.3000 [1]
Naugatex 2006	.2900 [1]
Naugatex 2105 and 2107	.3200 [1]
Naugatex 2108	.3000 [1]
Naugatex 2113	.2900 [1]
Naugatex J-8174-F	.3200 [1]
Naugatex J-8855	.3000 [1]
Naugatex J-9049	.2750 [1]
Naugatex J-9064	.3050 [1]
Pliolite 2000	.2775 [3]
Pliolite 2001	.2775 [3]
Pliolite 2076	.2900 [3]
Pliolite 2104	.3200 [3]
Pliolite 2105	.3200 [3]
Pliolite 2107	.3200 [3]
Pliolite 2108	.3000 [3]
S-2000 and S-2006	.2600 [3]
S-2101	.2600 [3]
S-2105	.2800 [3]
S-2108	.2900 [3]
Tylac 400	.3000 [1]
Tylac 410 and 420	.2900 [1]
Tylac 450-A	.2750 [1]
Tylac 3040 and 3340	.3200 [1]

Neoprene

Neoprene Latex 60	.4000 [3]
Neoprene Latex 571	.3700 [3]
Neoprene Latex 572	.3900 [3]
Neoprene Latex 601-A	.4000 [3]
Neoprene Latex 673	.5000 [3]
Neoprene Latex 735	.3800 [3]
Neoprene Latex 736	.3800 [3]
Neoprene Latex 842-A	.3700 [3]
Neoprene Latex 950	.4700 [3]

Polysulfide Rubbers

Thiokol Type MX	.8000 [3]
Thiokol Type WD-2	1.2500 [3]
Thiokol Type WD-6	.8000 [3]

Notes: (1) Freight allowed. (2) Freight extra. (3) Freight prepaid. *Covers a wide range of compounds. Readers are urged to check specific prices with producers.

Suppliers are your Materials Listed in the Market Prices Section?
If not, forward full information to —
Market Editor

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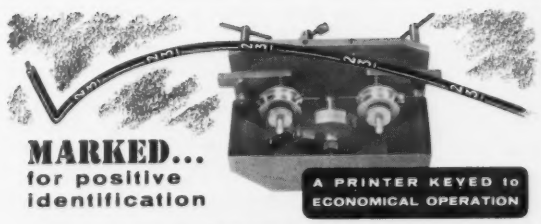

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MARKETS

(continued)

Reclaimed Rubber

Reclaimed rubber consumption for 1960 is estimated at 278,600 tons, compared with 290,410 tons in 1959. Consumption of 284,000 tons is forecast in 1961. Total reclaim used in November was 20,850 long tons, a decline from the October figure of 23,269. Total reclaim used in the first 11 months of 1960 was 258,680 long tons, a decline from the 267,192 tons consumed in the same period of 1959.

Tires and other tire products used 115,915 long tons of reclaim during the first nine months of 1960, a slight gain over the 115,897 tons used in the same 1959 period. Non-tire products, including wire and cable, used 98,646 long tons in the first nine months of 1960, a decrease from the 103,536 ton figure reported for the first nine months of 1959. Wire and cable products used 126 tons of reclaim in the first nine months of 1960, a decline from the 171 tons used in the like period of 1959. Current quotations follow:

(Prices for All Areas Except West Coast)
(Average price, carload quantities, minimum freight allowed)

	per lb.
First Line Whole Tire	.11½
First Line Whole Tire Stainless	.12¼
Second Line Whole Tire	.11
Third Line Whole Tire	.10¾
Fourth Line Whole Tire	.10¼
Black Carcass	.15⅜
Peelings	.11½
Butyl Tube	.16
Natural Rubber Black Tube	.17
Natural Rubber Red Tube	.21
Mechanical, Light Color, Low Gravity	.26
Mechanical, Light Color, Medium Gravity	.20

Scrap Rubber

There has been very little change in the scrap rubber market since our last report. With many reclaimers closed for inventory during the year-end holiday, the market was understandably quiet.

Although prices have held fairly steady for the past few months, a tendency toward lower prices has become evident in some grades, including mixed tires, No. 1 peelings and butyl rubber tubes.

Some hope has been expressed for an up-turn in the reclaim field early in 1961 which could result in an increased demand for scrap rubber. Current quotations follow:

(Prices Delivered Akron)

Mixed tires	ton	14.00
Light colored carcass	lb.	.05¾
No. 1 peelings	ton	40.00
No. 2 peelings	ton	28.00
No. 3 peelings	ton	23.00
Buffings	ton	16.00
Truck and Bus S.A.G.	ton	22.00
Passenger S.A.G.	ton	20.00
Natural Rubber Red Tubes	lb.	.07½
Natural Rubber Black Tubes	lb.	.07
Butyl Rubber Tubes	lb.	.06½

Tire Fabrics

A new type of nylon yarn said to increase the fatigue resistance of tires by more than 10 per cent, has been introduced by the Chemstrand Corp. The new nylon yarn, designated Type FRN, is said to surpass in fatigue resistance any nylon yarns currently used. The yarn was tested extensively both in the laboratory and in fleet trials, according to Chemstrand, with over 500,000 tire miles clocked on indoor wheel equipment and more than 750,000 tire miles on fleet tests.

Competition for Rayon

The new yarn, engineered specifically for aircraft, automobile and truck tires, should be of considerable aid to nylon in its competitive battle with Tyrex rayon tire yarns, reports the company. It was declared that the new development will not affect the price of nylon tire yarn.

The tests indicate that the fatigue resistance factor in tires made with Type FRN is increased over 10 per cent compared to tires made with nylon now being used in regular commercial production. According to Chemstrand, the increased fatigue resistance will provide a higher percentage of tires suitable for retreading and an increase in the number of times a single tire can be retreaded.

Mexican Plant Stymied

Chemstrand reports that its plans for a nylon plant in Mexico have been stymied. According to the firm, water rights at the site of the proposed plant near Mexico City are tied up and unavailable to Chemstrand. The venture is still alive, and Chemstrand Overseas, S.A., a subsidiary, reports that it will begin looking for another site in Mexico if details cannot be worked out.

Production Figures

Production of tire cord and tire cord fabric in the third quarter of 1960 totaled 85,300,000 pounds, a sizable decline of 20 per cent from the 106,800,000 pounds in the second quarter. With cotton continuing at nominal levels, rayon comprised 61 per cent of both the second and third quarter production, nylon being the balance of 39 per cent of the man-made fiber total.

(Prices f.o.b. Shipping Point)

Rayon Tire Cord

1100	lb.	.62½
1650	lb.	.62
2200	lb.	.62½

Nylon Tire Cord

210	lb.	1.75
840	lb.	1.47

Rayon Graded Fabric

1100	lb.	.69
1650	lb.	.63½
2200	lb.	.63

Cotton Chafers

8.9 oz. (per square yard)	lb.	.71
9.25 oz. (per square yard)	lb.	.72
11.65 oz. (per square yard)	lb.	.66
14.4 oz. (per square yard)	lb.	.75

Liquid Latex

Natural: In the first eleven months of 1960, 45,128 long tons of natural rubber latex (solids) were imported into the United States, just about 27,370 tons less than in the same period of the previous year. Consumption, too, has been running far behind. In the first eleven months of 1960, 47,127 long tons of natural latex were consumed against the 66,539 long tons consumed in the first eleven months of the previous year.

November imports of natural rubber latex were 2,960 long tons, a gain over October imports of 2,042 long tons. Re-exports for November were 200 long tons, a drop from 404 long tons for October. Net supplies for November were 2,760 long tons, and total stocks at the end of November were 9,470 long tons. In contrast, October net was 1,638 long tons and total stocks on hand at the end of October were 10,634 long tons.

As the price of liquid latex continues to sag there is every likelihood that an increase in consumption is in the offing. This is the characteristic trend of the latex field and 1961 should prove no exception if prices hold at or near their present levels. The feast-or-famine nature of the latex field still holds true.

Synthetic: The synthetic latices still show signs of increases in both production and consumption. While most other consumption-production factors have remained at or near 1959 levels, these synthetic latices have shown a steady gain. This is expected to continue in the coming year.

Cotton

The price of middling uplands on the New York Cotton Exchange moved in a range of 205 points since our last report (December 1), high for the period being 32.30c reached on December 1 through7, and low being 30.25c reached on December 21 through 30. The average price of middling uplands for December was 31.60c based on 21 trading days. This compares with an average of 32.27c in November.

Cotton prices were holding firm during the last week of 1960, as the cotton trade waited to see what kind of a farm policy will be evolved by the incoming administration.

With so many troubles piling up from the present loan and subsidy program, the climate in Congress appears more favorable for some kind of direct payment to farmers, despite opposition from the American Farm Bureau Federation.

The American cotton industry does not seem able to rise out of its lethargic state. Cotton mills are tied to a cotton program compelling them to pay the highest world price for raw cotton, pay highest world wages to get it processed, and then sell it in a world that wants more lower priced goods. All this points to a textile boom in West Europe, according to some sources.

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STATISTICS of the industry

PERTINENT INDUSTRY DATA

Natural Rubber in the United States

(Including Latex and Guayule)

(All Quantities in Long Tons)

Year	New Supply	Consumption	Re-Exports	Stocks On Hand at End of Period
1933	418,902	412,400	20,576	365,000
1934	463,018	462,500	23,856	355,000
1935	467,146	495,500	11,391	303,000
1936	488,145	575,000	12,582	223,000
1937	600,479	543,600	7,902	262,204
1938	411,983	437,031	5,652	231,500
1939	499,473	592,000	13,125	125,800
1940	818,243	648,500	7,060	288,864
1941	1,029,007	775,000	5,376	533,344
1942	282,653	376,791	10,856	422,714
1943	55,329	317,634	20,815	139,594
1944	107,834	144,115	9,665	93,650
1945	135,672	105,429	6,743	118,715
1946	400,687	277,597	4,338	237,467
1947	688,354	562,661	4,101	129,038
1948	735,227	627,332	6,673	141,541
1949	660,792	574,522	6,253	106,619
1950	802,249	720,268	8,644	89,215
1951	733,048	454,015	2,603	76,569
1952	805,997	453,846	3,024	95,260
1953	647,150	553,472	8,376	112,316
1954	596,848	596,285	7,443	104,543
1955	635,174	634,800	10,611	110,105
1956	580,510	563,095	11,300	115,949
1957	499,121	539,761	10,146	100,901
1958	474,409	484,492	20,085	76,491
1959	526,048	555,044	18,750	79,405
1960:				
Jan.	34,795	46,354	1,373	76,156
Feb.	40,949	46,022	1,448	75,320
Mar.	38,580	47,205	1,522	81,599
Apr.	36,344	42,032	803	83,451
May	32,018	41,263	840	82,693
June	31,639	42,576	509	76,605
July	28,555	35,229	1,488	76,389
Aug.	39,596	37,258	912	82,385
Sept.	31,862	36,770	754	82,227
Oct.	24,594	26,312	1,150	76,116

Source: U. S. Department of Commerce.

U. S. Imports of Natural Rubber

Year	Dry: Long Tons	Dry: Declared Value	Latex: Long Tons	Latex: Declared Value	Total Imports
1940	781,202	303,308,823	33,789	14,593,466	814,991
1941	989,498	401,976,317	34,797	15,965,627	1,024,245
1942	266,276	112,537,426	10,646	5,630,667	276,922
1943	50,358	31,369,198	1,890	1,312,202	52,248
1944	103,847	73,908,549	3,091	2,092,211	106,938
1945	134,408	95,814,102	4,773	3,115,853	139,181
1946	376,502	228,796,110	8,421	5,843,085	384,923
1947	691,087	306,951,814	17,542	9,787,722	708,629
1948	702,293	290,849,177	32,745	18,288,223	735,038
1949	630,808	225,343,624	29,743	14,968,650	660,551
1950	747,109	416,222,598	54,401	41,764,486	801,510
1951	677,874	727,343,348	54,963	80,178,309	732,837
1952	756,987	578,179,519	48,228	40,563,116	805,215
1953	571,635	284,909,223	75,511	46,353,333	647,146
1954	522,364	219,098,143	74,483	42,755,029	596,847
1955	542,507	360,435,303	92,825	80,163,114	635,332
1956	499,479	334,990,045	71,709	61,795,844	564,321
1957	475,958	291,337,628	78,567	58,249,788	554,174
1958	406,059	153,127,066	67,593	45,047,040	473,652
1959	498,749	304,594,223	79,205	60,939,662	577,954
1960:					
Jan.	29,455	22,167,388	5,340	4,690,413	34,795
Feb.	35,137	27,281,957	5,812	5,411,873	40,949
Mar.	33,453	26,696,437	5,128	4,659,021	38,581
Apr.	31,408	25,659,607	4,940	4,690,140	36,348
May	26,637	21,962,099	5,830	4,853,091	32,467
June	28,304	23,661,317	3,335	3,152,266	31,639
July	25,072	21,637,414	3,483	3,335,694	28,555
Aug.	35,423	28,919,412	4,174	3,825,191	39,597
Sept.	24,848	23,321,841	2,541	2,259,381	27,389

Source: Bureau of the Census, U. S. Department of Commerce.

World Production of Natural Rubber

(Including Latex)

(Long Tons)

Year	Malaya	Indonesia	Ceylon	Viet Nam & Cambodia	Latin America*	Rest of World*	Total*
1951	605,346	814,406	105,000	52,136	29,777	278,262	1,885,000
1952	584,238	750,494	96,500	63,134	35,475	261,211	1,790,000
1953	574,390	692,164	98,610	74,545	35,318	250,182	1,725,000
1954	584,435	738,670	93,935	78,024	26,833	280,112	1,802,500
1955	639,128	733,786	93,830	80,172	6,000	344,584	1,897,500
1956	568,550	686,667	95,389	89,072	22,457	336,015	1,857,000
1957	638,706	684,515	98,164	58,440	28,351	381,824	1,890,000
1958	663,644	614,561	100,196	103,613	26,268	446,718	1,955,000
1959	698,249	721,359	91,696	108,398	23,962	421,336	2,065,000
1960:							
Jan.	64,948	45,928	10,875	10,305	4,003	33,941	170,000
Feb.	54,544	50,274	4,285	949	3,667	38,781	152,500
Mar.	54,946	50,567	10,199	2,941	3,493	40,354	162,500
Apr.	46,917	55,143	9,006	7,325	2,498	34,111	155,000
May	56,839	48,985	4,521	10,632	2,498	36,525	160,000
June	58,301	48,774	7,652	10,850	600	33,823	160,000
July	63,146	46,018	6,689	10,802	600	27,745	155,000
Aug.	62,164	34,117	8,394	10,276	600	34,449	150,000

Source: International Rubber Study Group. * Estimated.

World Consumption of Natural and Synthetic Rubber

(Including Latex)

(Long Tons)

Year	United States	United Kingdom	Canada	Europe*	Rest of World*	Total*
1950	1,258,557	222,425	68,695	448,500	287,055	2,285,000
1951	1,214,298	238,101	70,809	476,500	314,941	2,312,500
1952	1,261,413	202,179	67,099	550,000	254,901	2,335,000
1953	1,338,309	211,453	73,394	521,000	343,606	2,500,000
1954	1,233,012	247,612	71,656	544,250	408,094	2,505,000
1955	1,529,699	266,804	84,528	630,000	464,250	2,980,000
1956	1,436,482	232,345	91,458	775,500	489,215	3,025,000
1957	1,464,640	239,021	88,379	777,250	565,710	3,135,000
1958	1,364,404	238,439	83,904	905,000	638,353	3,230,000
1959	1,626,370	259,655	101,484	985,250	689,741	3,662,500
1960:						
Jan.	141,487	23,087	8,138	82,750	69,538	325,000
Feb.	139,225	22,861	8,733	78,000	68,681	317,500
Mar.	144,932	27,853	8,872	79,750	56,093	317,500
Apr.	132,284	21,946	7,106	71,000	72,664	305,000
May	133,256	23,340	7,051	82,000	61,853	307,500
June	138,425	26,328	8,196	96,750	67,801	337,500
July	114,642	18,991	6,393	83,000	64,474	287,500
Aug.	125,836	17,266	6,253	79,250	66,395	295,000

Source: International Rubber Study Group. * Estimated.

Rim Production

	1955	1956	1957	1958	1959
Passenger Car	38,092,080	27,109,610	27,301,567	20,665,688	25,412,177
Truck & Bus	6,642,329	6,315,428	5,468,223	3,887,910	5,019,261
Agricultural	1,931,768	1,416,938	1,368,127	1,218,240	1,386,866
Earth Mover	38,849	88,812	67,289	61,883	111,077
Total	46,705,036	34,930,788	34,205,206	25,833,721	31,929,381

	1960 June	July	Aug.	Sept.	Oct.	Nov.
Passenger Car	2,473,789	1,551,209	1,463,423	2,155,072	2,579,065	2,447,595
Truck and Bus	426,862	343,817	268,438	281,039	269,749	258,821
Agriculture	79,521	24,771	37,514	43,697	36,798	36,397
Earth Mover	8,273	4,532	9,249	3,996	9,850	2,638
Total	2,988,445	1,924,329	1,778,624	2,483,804	2,895,462	2,745,451

Source: The Tire & Rim Association, Inc.

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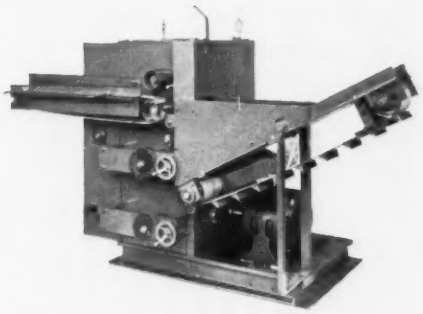

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Synthetic Rubber in the United States

(All Quantities in Long Tons)

New Supply

Year	GR-S	Neoprene	Butyl	N-Type	Total
1951	704,529	58,907	76,475	15,333	855,244
1952	654,854	65,745	81,630	16,228	818,447
1953	680,728	80,495	79,801	20,198	861,222
1954	490,405	69,150	58,802	21,396	639,753
1955	801,145	91,357	56,179	32,623	982,304
1956	876,982	99,412	75,873	34,547	1,086,814
1957	913,321	110,721	67,418	33,618	1,125,078
1958	872,565	97,806	54,113	32,431	1,056,915
1959	1,134,379	124,815	82,704	43,588	1,385,486
1960:					
Jan.	107,519	11,958	8,325	3,808	131,610
Feb.	105,030	12,106	6,917	3,126	127,179
Mar.	110,239	11,305	7,828	3,613	132,985
Apr.	98,464	11,879	8,144	3,130	121,617
May	102,850	11,401	10,115	3,113	127,479
June	99,175	11,614	9,723	2,891	123,403
July	95,892	10,210	8,484	2,519	117,105
Aug.	99,213	10,120	9,999	3,247	122,579
Sept.	90,607	10,078	9,406	3,211	113,302
Oct.	87,857	11,219	8,711	3,204	110,991

Consumption

1952	666,420	55,522	71,229	13,866	807,037
1953	624,181	65,900	77,826	16,929	784,836
1954	500,345	57,203	61,464	17,715	636,727
1955	741,997	72,876	53,991	26,035	894,899
1956	727,789	74,887	49,615	24,976	877,267
1957	767,218	75,461	55,413	25,187	923,279
1958	730,196	69,694	53,432	26,590	880,912
1959	886,275	84,955	65,454	34,638	1,071,322
1960:					
Jan.	78,891	7,361	6,093	2,788	95,133
Feb.	76,999	7,369	6,070	2,765	93,203
Mar.	81,065	7,693	6,324	2,645	97,727
Apr.	75,849	6,525	5,492	2,386	90,252
May	77,423	6,471	5,602	2,497	91,993
June	80,951	7,129	5,150	2,619	95,849
July	67,853	4,936	4,597	2,027	79,413
Aug.	73,761	7,200	4,680	2,737	88,578
Sept.	72,593	7,096	4,901	2,740	87,330
Oct.	74,606	6,920	4,552	2,706	88,784

Exports

1952	9,467	9,813	126	2,695	22,101
1953	7,692	11,494	237	3,245	22,668
1954	11,069	12,062	2,831	4,155	30,117
1955	60,704	18,098	9,895	4,593	93,290
1956	112,366	21,909	8,699	6,194	149,168
1957	157,977	30,242	8,748	6,377	203,344
1958	142,069	31,337	13,793	6,718	193,917
1959	211,300	39,551	21,700	8,256	280,843
1960:					
Jan.	21,967	4,185	2,396	527	29,075
Feb.	22,791	4,588	1,528	740	29,647
Mar.	27,081	4,874	1,803	532	34,290
Apr.	28,765	5,268	2,006	676	36,715
May	23,337	4,213	1,936	1,320	30,806
June	23,130	3,699	2,062	464	29,355
July	19,721	4,446	3,792	616	28,575
Aug.	22,753	3,519	3,494	501	30,267
Sept.	16,836	3,340	3,500	389	24,065

Stocks

1951	105,271	8,379	12,481	3,821	129,912
1952	83,861	8,535	22,716	3,875	118,987
1953	135,153	11,480	24,866	4,346	175,845
1954	115,499	11,349	19,267	4,280	150,395
1955	108,989	12,220	10,500	6,030	137,739
1956	151,763	14,077	28,744	7,934	202,518
1957	140,199	18,843	31,489	7,454	197,985
1958	143,533	15,688	18,770	7,292	185,283
1959	174,606	14,164	13,188	8,888	210,846
1960:					
Jan.	183,242	15,143	14,039	9,198	221,622
Feb.	186,166	13,930	12,735	8,352	221,183
Mar.	189,308	13,491	12,764	8,175	223,738
Apr.	185,464	13,796	14,021	8,230	221,511
May	188,808	14,243	16,014	8,267	227,332
June	183,996	15,411	18,912	7,713	226,032
July	192,552	16,954	18,689	7,498	235,693
Aug.	198,695	16,072	20,877	7,096	242,740
Sept.	198,067	16,590	21,271	7,031	242,959
Oct.	192,090	16,405	23,205	6,891	238,591

Source: U. S. Department of Commerce.

Natural and Synthetic Rubber Latex in the United States

(All Quantities in Long Tons)

New Supply

Year	Natural	GR-S	Neoprene	N-Type	Total Synthetic	Grand Total
1947	17,675	22,474	6,089	.....	28,563	46,238
1948	32,630	21,494	5,022	.....	26,516	59,146
1949	29,974	21,357	3,651	.....	25,008	54,982
1950	54,401	31,339	5,725	.....	37,064	91,465
1951	54,963	32,972	6,866	2,948	42,786	97,749
1952	48,228	42,273	7,598	4,164	54,035	102,263
1953	75,511	48,112	9,026	5,844	62,982	138,493
1954	74,483	48,379	8,214	6,866	63,459	137,942
1955	92,754	69,364	10,432	10,798	90,594	183,348
1956	72,013	69,720	10,642	10,650	91,012	163,025
1957	72,252	74,535	10,403	11,420	96,358	168,610
1958	67,591	65,669	10,679	11,560	87,908	155,499
1959	72,502	93,303	13,127	14,034	120,464	192,966
1960:						
Jan.	5,339	9,720	1,154	1,131	12,005	17,344
Feb.	5,812	9,862	1,085	1,098	12,045	17,857
Mar.	5,127	9,351	1,004	1,217	11,572	16,699
Apr.	4,935	9,408	1,137	917	11,462	16,397
May	5,380	8,162	1,250	1,009	10,421	15,801
June	3,335	7,541	965	973	9,479	12,814
July	3,483	6,481	953	983	8,417	11,900
Aug.	4,174	8,096	978	1,291	10,365	14,539
Sept.	2,541	9,397	1,119	1,299	11,815	14,356
Oct.	2,565	9,063	1,272	1,176	11,511	14,076

Consumption[1]

1947	13,909	22,500	6,500	....	29,000	42,909
1948	28,489	21,500	5,250	....	26,750	55,239
1949	36,117	21,500	3,750	....	25,250	61,367
1950	56,138	31,000	5,500	....	36,500	92,638
1951	46,750	31,031	6,279	2,628	39,938	86,688
1952	53,567	40,562	7,368	3,093	51,023	104,590
1953	67,375	46,473	7,981	3,654	58,108	125,483
1954	75,931	44,173	7,251	4,507	55,931	131,862
1955	86,478	63,982	8,736	8,495	81,213	167,691
1956	74,082	62,762	8,708	8,021	79,491	153,573
1957	75,009	68,305	9,039	8,630	85,974	160,983
1958	70,183	60,283	9,555	10,549	80,387	150,570
1959	71,745	80,646	11,394	13,258	105,298	177,043
1960:						
Jan.	5,491	8,094	999	1,117	10,210	15,701
Feb.	5,463	7,838	969	1,000	9,807	15,270
Mar.	4,847	8,104	1,076	927	10,107	14,954
Apr.	4,199	7,154	913	976	9,043	13,242
May	3,655	6,821	868	978	8,667	12,322
June	3,975	7,147	1,033	981	9,161	13,136
July	2,912	5,433	729	780	6,942	9,854
Aug.	3,897	7,857	1,057	1,078	9,992	13,889
Sept.	4,250	7,458	942	1,122	9,522	13,772
Oct.	4,283	7,371	971	1,118	9,460	13,743

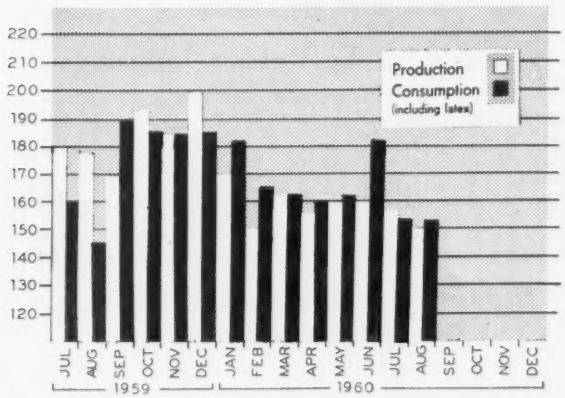
Stocks at End of Period

1947	5,033	....	....	....	....	5,033
1948	11,235	....	....	....	....	11,235
1949	5,063	....	....	....	....	5,063
1950	4,927	....	....	....	....	4,927
1951	4,752	3,727	1,245	532	5,504	10,256
1952	6,201	5,040	1,019	902	6,961	13,162
1953	13,532	4,794	1,117	721	6,632	20,164
1954	11,133	5,134	1,087	811	7,032	18,165
1955	13,203	6,980	1,236	1,807	10,203	23,406
1956	12,064	7,451	1,384	1,558	10,393	22,457
1957	14,454	8,347	1,267	1,974	11,588	26,042
1958	8,900	7,672	1,663	2,519	11,854	20,754
1959	12,717	8,226	1,581	2,883	12,690	25,067
1960:						
Jan.	12,781	7,781	1,680	2,799	12,260	25,041
Feb.	12,974	8,606	1,534	2,535	12,675	25,649
Mar.	13,964	8,055	1,518	2,492	12,065	26,029
Apr.	13,896	9,081	1,595	2,242	12,918	26,814
May	15,214	10,031	1,745	2,342	14,118	29,332
June	14,140	9,142	1,530	1,941	12,613	26,753
July	14,785	9,364	1,564	2,064	12,992	27,777
Aug.	13,690	8,641	1,333	1,967	11,941	25,631
Sept.	12,852	9,172	1,494	2,034	12,700	25,552
Oct.	10,634	10,000	1,626	1,999	13,625	24,259

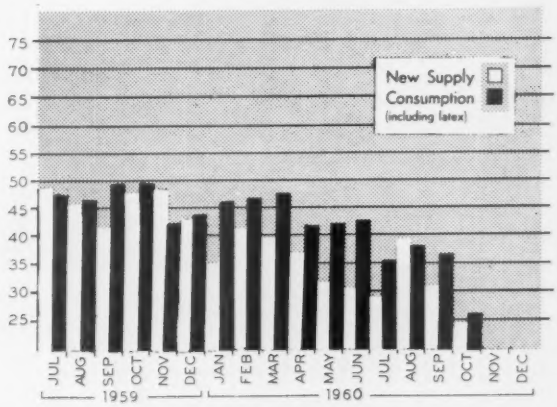
Source: U. S. Department of Commerce.
Note: (1) GR-S and Neoprene consumption estimated through 1950.

STATISTICS at a glance

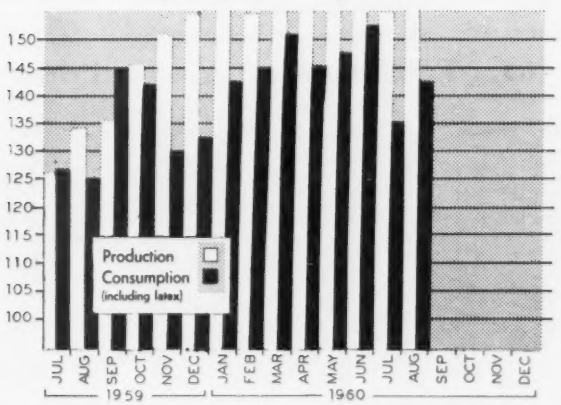
NATURAL RUBBER—WORLD
(thousands of long tons)



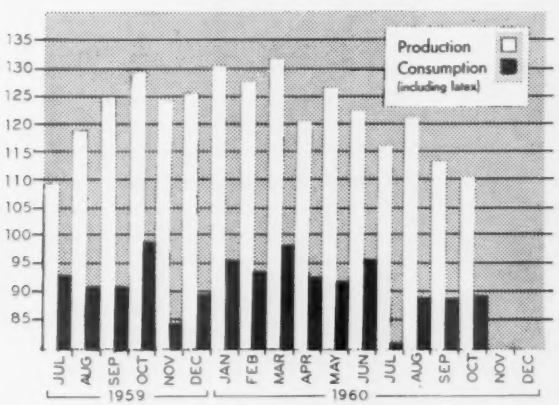
NATURAL RUBBER—UNITED STATES
(thousands of long tons)



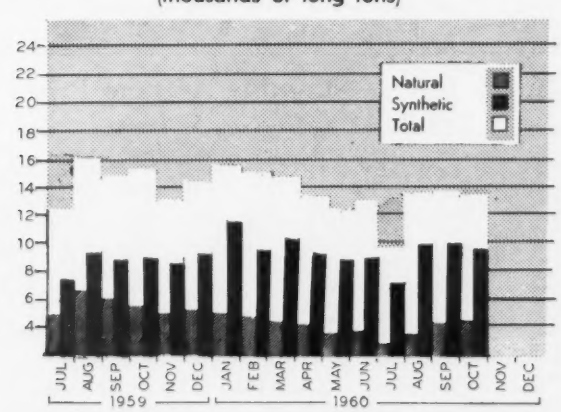
SYNTHETIC RUBBER—WORLD
(thousands of long tons)



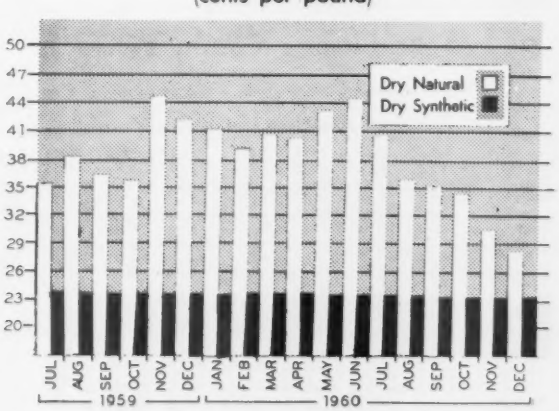
SYNTHETIC RUBBER—UNITED STATES
(thousands of long tons)



LATEX CONSUMPTION—UNITED STATES
(thousands of long tons)



PRICES—NATURAL AND SYNTHETIC
(cents per pound)



Rubber Industry Employment Earnings and Hours

All Rubber Products

Mo.	1959 Production Workers (thousands)	1959 Average Weekly Earnings	1959 Average Weekly Hours	1959 Average Hourly Earnings	1960 Production Workers (thousands)	1960 Average Weekly Earnings	1960 Average Weekly Hours	1960 Average Hourly Earnings
Jan.	199.1	$100.28	41.1	$2.45	208.0	$102.16	40.7	$2.51
Feb.	198.8	101.09	41.6	2.44	208.6	100.00	40.0	2.50
Mar.	201.5	103.74	42.0	2.43	207.5	97.71	39.4	2.48
Apr.	176.0	101.57	41.8	2.47	200.7	94.60	38.3	2.47
May	171.8	101.46	42.1	2.43	197.6	100.04	39.7	2.52
June	196.1	98.74	40.3	2.45	197.9	102.72	40.6	2.53
July	203.4	107.10	42.5	2.52	191.7	103.53	40.6	2.55
Aug.	203.8	105.53	42.3	2.49	197.0	100.15	39.9	2.51
Sept.	212.4	102.01	41.3	2.47	198.1			
Oct.	212.3	101.18	40.8	2.48	....	.....	...	...
Nov.	209.1	97.66	39.7	2.46	....	.....	...	...
Dec.	208.0	101.59	40.8	2.49	....	.....	...	...

Tires and Tubes

Jan.	76.9	117.55	41.1	2.87	77.9	119.80	40.2	2.98
Feb.	76.2	118.98	41.6	2.86	77.4	117.71	39.5	2.98
Mar.	77.9	122.96	42.4	2.86	78.8	113.68	38.8	2.93
Apr.	66.0	123.98	42.9	2.90	78.1	107.38	36.9	2.91
May	52.2	126.13	42.9	2.89	77.0	117.51	39.7	2.96
June	70.7	108.93	36.8	2.96	76.6	121.39	40.6	2.99
July	79.7	128.74	43.2	2.98	75.9	123.71	41.1	3.01
Aug.	78.4	127.74	43.3	2.95	75.9	115.25	39.2	2.94
Sept.	80.5	117.56	40.4	2.91	....	.....	...	...
Oct.	79.7	117.49	40.1	2.93	....	.....	...	...
Nov.	79.0	112.62	38.7	2.91	....	.....	...	...
Dec.	78.1	118.59	40.5	2.94	....	.....	...	...

Rubber Footwear

Jan.	17.1	78.20	39.9	1.96	19.0	79.40	39.5	2.01
Feb.	17.1	80.59	40.7	1.96	19.0	77.21	38.8	1.99
Mar.	17.4	79.79	40.3	1.98	18.9	78.61	39.5	1.99
Apr.	12.9	73.05	39.7	1.98	18.5	77.01	38.7	1.99
May	17.7	79.58	40.6	1.84	18.1	81.40	40.1	2.03
June	18.2	81.58	41.2	1.98	18.2	82.82	40.6	2.04
July	18.3	78.60	40.1	1.96	17.6	82.21	40.3	2.04
Aug.	18.4	79.17	40.6	1.95	18.4	81.20	40.2	2.02
Sept.	19.0	79.18	40.4	1.96	....	.....	...	...
Oct.	19.1	79.40	39.9	1.99	....	.....	...	...
Nov.	19.6	79.80	39.9	2.00	....	.....	...	...
Dec.	19.4	80.79	39.9	2.04	....	.....	...	...

All Other Rubber Products

Jan.	105.1	91.27	41.3	2.21	111.1	93.52	41.2	2.27
Feb.	105.5	91.96	41.8	2.21	112.2	91.76	40.6	2.26
Mar.	106.2	93.02	41.9	2.20	109.8	89.78	39.9	2.25
Apr.	97.1	90.03	41.3	2.22	104.1	88.43	39.3	2.25
May	101.9	92.18	41.9	2.18	102.5	90.12	39.7	2.27
June	107.2	94.98	42.4	2.24	103.1	92.34	40.5	2.28
July	105.4	95.40	42.4	2.25	98.2	91.66	40.2	2.28
Aug.	107.0	93.21	41.8	2.23	102.7	91.88	40.3	2.28
Sept.	112.9	94.73	42.1	2.25	....	.....	...	...
Oct.	113.5	93.38	41.5	2.25	....	.....	...	...
Nov.	110.5	89.87	40.3	2.23	....	.....	...	...
Dec.	110.5	92.93	41.2	2.25	....	.....	...	...

Source: U. S. Department of Labor.

Note: Data are based upon reports from cooperating establishments covering both full and part-time employees who work during, or received pay for, any part of the pay period ending nearest the 15th of the month. These employment series have been adjusted to first quarter 1954 benchmark levels indicated by data from government social insurance programs. Hours and earnings data pertain only to production and related workers.

Spot Closing Cotton Prices

(Middling Upland Grade—New York Market—in Cents)

Average Monthly Price Per Pound

	1953	1954	1955	1956	1957	1958	1959	1960
Jan.	33.24	34.16	35.07	35.24	34.82	36.31	35.67	33.09
Feb.	33.76	35.00	35.04	36.26	34.82	35.83	35.69	33.20
Mar.	34.10	35.23	34.33	36.70	35.35	36.05	35.71	33.54
Apr.	33.85	35.22	34.23	36.43	35.43	36.00	36.05	34.10
May	34.30	35.34	34.80	36.65	35.40	36.27	36.24	34.15
June	34.11	35.17	34.83	36.67	35.45	36.33	36.05	34.22
July	34.20	35.37	34.61	35.43	35.49	36.51	34.67	33.96
Aug.	33.82	35.19	34.53	34.31	35.15	36.36	33.17	32.59
Sept.	33.69	35.46	33.85	34.35	34.74	36.00	32.99	32.39
Oct.	33.53	35.24	33.93	34.45	35.09	36.23	32.77	32.21
Nov.	33.60	34.80	34.87	34.56	36.06	36.24	32.79	32.27
Dec.	33.52	35.03	34.95	34.56	36.50	35.75	33.02	31.60
Average for Year	33.81	35.10	34.59	35.50	35.36	36.16	34.57	33.10

Note: The Government established a ceiling of 45.76c for spot cotton on March 3, 1951. (a) Trading suspended during February.

Production Index for the Rubber Industry

(1957 = 100)

(Based on man-hours)

	1958	1959	1960		1958	1959	1960
Jan.	116	108	118	July	125	128	117
Feb.	114	113	117	Aug.	131	120	115
Mar.	116	112	115	Sept.	136	120	111
Apr.	112	104	115	Dec.	140	116	...
May	113	105	117	Aug.	131	120	...
June	125	117	122	Sept.	136	120	...

Sales by the Rubber Industry

(in Millions of Dollars*)

	1958	1959	1960		1958	1959	1960
Jan.	448	508	530	July	478	519	480
Feb.	413	490	570	Aug.	438	492	480
Mar.	396	506	510	Sept.	464	544	510
Apr.	429	543	530	Oct.	493	555	490
May	428	524	550	Nov.	472	482	...
June	445	520	520	Dec.	518	500	...

Rubber Manufacturers' Inventories

(in Millions of Dollars*)

	1958	1959	1960		1958	1959	1960
Jan.	1,100	998	1,140	July	980	1,075	1,230
Feb.	1,087	1,022	1,140	Aug.	1,024	1,113	1,240
Mar.	1,069	1,030	1,160	Sept.	1,024	1,115	1,200
Apr.	1,047	1,015	1,190	Oct.	1,022	1,115	1,160
May	1,020	995	1,180	Nov.	1,018	1,120	...
June	986	1,013	1,200	Dec.	994	1,140	...

Source: U. S. Department of Commerce.

Notes: * Adjusted for seasonal variation.

No. 1 R.S.S.—Annual Average Prices

(New York Market—Cents per Pound)

Year	High	Low	Avg.	Year	High	Low	Avg.
1919	57	38½	48.70	1940	24	18¼	20.10
1920	56½	16	36.30	1941	24⅞	19⅛	22.40
1921	21¾	11½	16.36	1942	22½	22½	22.50
1922	28⅜	13⅝	17.50	1943	22½	22½	22.50
1923	37⅛	24¾	29.45	1944	22½	22½	22.50
1924	40⅛	17⅜	26.20	1945	22½	22½	22.50
1925	121	34⅜	72.46	1946	22½	22½	22.50
1926	88½	36¾	48.50	1947	25	14	20.00
1927	41¾	33	37.72	1948	25	18	21.99
1928	41¼	17	22.48	1949	19¾	15⅞	17.57
1929	26⅞	15½	20.55	1950	86	18	41.10
1930	16½	7½	11.98	1951	76	52	(a)
1931	8⅝	4¼	6.17	1952*	33	26½	29.15
1932	4¾	2½	3.49	1953	31⅞	19⅞	24.21
1933	9⅞	2⅞	5.96	1954	34½	19½	23.61
1934	15⅞	8¾	12.92	1955	52	29⅜	39.16
1935	13¾	10½	12.37	1956	45	26½	34.24
1936	23	13½	16.41	1957	37⅜	26⅝	31.13
1937	26⅞	14	19.39	1958	32⅝	24⅜	28.13
1938	17⅛	10¼	14.64	1959	49	29¾	36.56
1939	24	14⅛	17.57	1960	47½	28⅜	38.09

Note: Price was fixed by Government on August 6, 1941, at 22½c a pound for non-war uses. Free trading was resumed May 1, 1947. (a) Free trading suspended March 31, 1951. GSA selling price ranged between 52 and 66c during balance of year. * Free trading was resumed on July 1, 1952; figures represent only July through December, 1952.

No. 1 R.S.S.—Monthly Average Prices

(New York Market—Cents per pound)

	1953	1954	1955	1956	1957	1958	1959	1960
Jan.	29.40	20.22	33.92	41.70	33.32	27.15	30.34	41.18
Feb.	27.57	19.98	34.90	33.68	30.43	26.32	30.26	39.33
Mar.	26.59	20.16	31.08	33.68	31.76	26.65	31.62	40.74
Apr.	24.66	22.06	31.75	31.75	32.23	26.44	33.72	40.35
May	25.52	21.96	31.35	29.61	32.12	25.51	36.48	43.62
June	24.42	23.01	34.74	30.54	32.80	26.20	34.31	45.70
July	23.64	24.12	40.84	33.91	32.88	27.70	35.19	40.90
Aug.	23.06	23.00	48.85	35.69	32.13	28.72	38.43	36.69
Sept.	23.06	23.00	48.27	32.64	29.94	29.49	40.22	35.04
Oct.	20.82	26.57	43.81	32.68	29.24	31.06	41.50	34.06
Nov.	20.58	28.07	44.95	35.18	27.47	32.10	45.16	30.63
Dec.	20.92	29.88	48.40	37.01	29.25	30.28	41.46	28.81
Average for Year	24.21	23.61	39.16	34.24	31.13	28.13	36.56	38.09

Note: (a) Free trading suspended March 31, 1951, and resumed on July 1, 1952.

Automotive Pneumatic Casings

(Thousands of Units)

	Shipments					
	Original Equipment	Replacement	Export	Total	Production	Inventory End of Period
1951 (total)	32,153	44,612	1,677	78,442	83,405	8,765
Passenger Car.	26,729	34,226	723	61,678	65,546	6,973
Truck and Bus	5,424	10,386	954	16,764	17,859	1,791
1952 (total)	29,484	54,342	1,520	85,346	90,411	14,110
Passenger Car.	24,106	45,458	741	70,305	74,341	11,251
Truck and Bus	5,378	8,884	779	15,041	16,070	2,859
1953 (total)	37,949	55,124	1,543	94,617	96,150	15,720
Passenger Car.	33,106	45,798	809	79,713	81,455	13,044
Truck and Bus	4,843	9,326	734	14,904	14,696	2,676
1954 (total)	33,333	55,155	1,753	90,241	89,141	14,762
Passenger Car.	29,741	47,044	928	77,713	76,794	12,217
Truck and Bus	3,591	8,111	826	12,528	12,347	2,545
1955 (total)	47,374	59,246	1,879	108,499	112,178	18,778
Passenger Car.	42,574	50,189	966	93,730	97,223	15,963
Truck and Bus	4,800	9,057	912	14,769	14,955	2,815
1956 (total)	35,422	62,146	1,757	99,325	100,406	79,872
Passenger Car.	30,873	53,252	875	85,000	85,546	16,494
Truck and Bus	4,548	8,894	883	14,325	14,859	3,378
1957 (total) ...	36,765	65,150	1,733	103,649	106,940	250,536
Passenger Car.	32,725	56,603	889	90,217	93,542	210,146
Truck and Bus	4,053	8,546	846	13,432	13,398	40,384
1958 (total)	26,783	70,797	1,348	98,928	96,563	20,939
Passenger Car.	23,408	61,570	717	85,696	83,636	17,778
Truck and Bus	3,375	9,226	631	13,232	12,927	3,161
1959 (total)	34,163	76,812	1,430	112,405	117,875	26,933
Passenger Car..	29,746	66,797	786	97,329	102,637	23,578
Truck and Bus	4,417	10,015	644	15,076	15,238	3,355
1960:						
Jan. (total)	4,333	6,823	156	11,322	10,325	25,943
Passenger Car.	3,912	6,006	111	10,030	9,011	22,567
Truck and Bus	421	826	45	1,292	1,315	3,376
Feb. (total)	3,996	6,047	136	10,179	10,772	26,473
Passenger Car .	3,569	5,257	78	8,904	9,371	22,972
Truck and Bus	421	789	59	1,275	1,401	3,502
Mar. (total)	3,753	5,827	157	9,737	11,115	27,921
Passenger Car .	3,333	5,156	90	8,578	9,679	24,144
Truck and Bus	421	671	67	1,158	1,436	3,777
Apr. (total)	3,584	7,348	182	11,114	10,517	27,401
Passenger Car .	3,200	6,558	114	9,872	9,165	23,512
Truck and Bus	385	790	68	1,243	1,352	3,889
May (total)	3,724	7,306	157	11,188	10,779	26,967
Passenger Car .	3,361	6,542	78	9,981	9,458	22,985
Truck and Bus	363	764	80	1,207	1,321	3,982
June (total) ...	3,449	7,892	174	11,515	10,892	26,359
Passenger Car .	3,098	7,105	94	10,297	9,559	22,271
Truck and Bus	352	787	80	1,218	1,332	4,088
July (total)	2,735	7,228	150	10,113	9,788	26,108
Passenger Car..	2,456	6,377	82	8,915	8,680	22,097
Truck and Bus	279	851	68	1,197	1,108	4,011
Aug. (total)	1,578	7,213	151	8,941	9,147	26,298
Passenger Car..	1,359	6,389	76	7,824	8,061	22,326
Truck and Bus	219	823	75	1,117	1,085	3,972
Sept. (total)	2,950	6,560	120	9,630	9,184	25,893
Passenger Car.	2,676	5,749	59	8,484	8,158	22,037
Truck and Bus	273	811	61	1,146	1,026	3,856
Oct. (total)	3,589	6,304	121	10,014	9,530	25,499
Passenger Car.	3,342	5,366	53	8,760	8,461	21,816
Truck and Bus	247	938	62	1,254	1,069	3,683

Source: The Rubber Manufacturers Association, Inc.

Automobile Production in U. S.

(Civilian Production Only)

Year	Passenger Cars	Trucks	Total	Year	Passenger Cars	Trucks	Total
1940	3,692,328	721,637	4,413,965	1950	6,665,836	1,332,263	7,998,099
1941	3,744,500	875,381	4,619,681	1951	5,337,729	1,420,432	6,758,161
1942	220,814	133,083	353,897	1952	4,320,794	1,212,790	5,533,584
1943	0	4,501	4,501	1953	6,121,787	1,202,196	7,323,983
1944	0	124,819	124,819	1954	5,558,897	1,038,045	6,596,942
1945	83,792	313,643	397,435	1955	7,920,186	1,245,018	9,165,204
1946	2,148,699	930,760	3,079,429	1956	5,816,109	1,100,417	6,916,525
1947	3,558,178	1,220,634	4,778,812	1957	6,113,344	1,097,006	7,210,350
1948	3,909,270	1,363,856	5,132,090	1958	4,257,812	874,278	5,132,090
1949	5,108,841	1,123,736	6,232,577	1959	5,591,243	1,134,858	6,726,101
1959:							
Jan.	539,451	96,044	635,495	July	548,524	114,687	663,211
Feb.	476,977	99,973	576,950	Aug.	255,831	60,147	315,978
Mar.	575,012	111,355	686,367	Sept.	229,410	79,573	308,983
Apr.	585,789	116,910	702,699	Oct.	537,159	94,993	632,152
May	545,001	114,995	659,996	Nov.	267,829	53,968	321,797
June	554,878	119,544	674,422	Dec.	475,382	72,669	548,051
1960:							
Jan.	676,712	115,268	791,980	July	421,355	79,444	500,799
Feb.	656,579	125,938	782,517	Aug.	324,020	65,948	389,968
Mar.	659,730	131,169	780,899	Sept.	386,694	77,038	463,732
Apr.	588,046	114,590	702,636	Oct.	627,678	75,034	702,712
May	607,191	118,023	727,214	Nov.	600,495	86,957	687,452
June	605,582	111,420	717,002	Dec.	.....	.....	.....

Source: Automobile Manufacturers Association.
Note: Figures are based on factory sales. Revisions are made from time to time in these figures and the latest issue should be consulted for accuracy.

Automotive Inner Tubes

(Thousands of Units)

	Shipments					
Year	Original Equipment	Replacement	Export	Total	Production	Inventory End of Period
1948	26,833	40,548	1,119	68,499	70,033	9,641
1949	31,521	31,450	887	63,858	65,114	10,657
1950	41,240	42,671	811	84,723	80,179	..
1951	32,151	32,284	1,071	65,507	67,249	10,094
1952	29,451	32,985	1,014	63,449	65,073	12,036
1953	37,957	36,072	878	74,907	74,425	11,874
1954	25,071	35,576	945	61,593	48,279	9,519
1955	5,001	33,387	1,001	39,389	35,900	6,833
1956	3,100	32,358	1,040	36,498	34,405	6,109
1957	3,046	35,687	1,076	39,806	39,774	80,077
1958	2,678	37,872	870	41,420	41,266	8,602
1959	3,624	41,522	891	46,037	46,059	10,536
1960:						
Jan.	365	4,964	62	5,391	3,899	8,924
Feb.	370	3,554	87	4,011	4,043	9,002
Mar.	365	2,807	111	3,282	4,241	10,113
Apr.	330	2,862	114	3,306	3,628	10,495
May	307	2,932	91	3,330	3,611	10,852
June	295	3,154	98	3,547	3,444	10,700
July	242	3,103	94	3,440	3,261	10,627
Aug.	169	3,056	83	3,308	3,017	10,254
Sept.	232	2,563	100	2,894	3,024	10,446
Oct.	222	2,666	111	3,000	3,067	10,589

Source: The Rubber Manufacturers Association, Inc.

Vinyl and Vinyl Copolymer Resins—Sales

(Thousands of Pounds—Resin Content)

	Polyvinyl Chloride and Copolymer Resins							All Other Vinyl Resins		
	Film	Sheeting	Molding & Extrusion	Textile & Paper Treating	Flooring	Protective Coatings	All Other Uses	Adhesives	All Other Uses	Grand Total
1956	78,063	55,598	206,726	62,931	65,384	28,522	71,859	36,565	115,151	720,799
1957	90,543	56,344	216,517	66,392	81,357	31,519	50,637	41,665	113,396	748,370
1958	72,404	67,594	214,701	63,050	113,583	28,913	68,307	52,904	117,752	801,208
1959	85,136	125,639	304,711	64,703	151,840	31,371	94,418	57,599	159,528	1,074,945
1960:										
Jan.	8,846	10,244	21,253	5,012	12,989	2,715	8,151	4,551	12,433	86,194
Feb.	9,044	10,382	24,234	5,019	13,722	2,602	7,585	4,811	13,849	91,248
Mar.	9,106	10,294	25,663	5,127	14,718	3,171	9,510	6,149	14,652	108,390
Apr.	8,272	10,816	22,835	5,157	12,811	3,431	8,482	4,797	12,644	89,245
May	7,610	11,523	24,221	5,466	13,103	3,449	8,194	4,891	12,555	91,112
June	9,036	12,074	23,683	5,332	12,489	3,846	11,534	5,265	11,712	94,971
July	5,861	9,805	18,414	3,956	10,107	3,485	9,155	4,116	11,773	76,672
Aug.	9,005	9,971	26,087	7,021	13,739	3,874	12,383	5,539	12,106	99,725
Sept.	7,662	11,095	25,116	5,571	15,723	3,922	9,510	4,884	13,378	96,861
Oct.	9,176	11,109	25,490	5,175	15,194	2,887	11,304	5,087	12,391	97,813

Source: Chemical Division, U. S. Tariff Commission.

Various Compounding Materials Consumed by the Rubber Industry

Material	1952	1953	1954	1955	1956	1957	1958
Antimony, Primary							
Short tons	66c	20c	49c	78	156	284	265
% of total	.004	.001	.004	.006	.010	.024	.022
Asphalt: [a]							
Short tons	33,288	.....	.....	.....	.....	.....	.....
% of total	0.4	.....	.....	.....	.....	.....	.....
Barite (Barytes):							
Short tons	18,000	21,000	20,000	25,104	22,101	21,782	18,387
% of total	2.0	2.0	2.0	2.0	2.0	1.0	2.0
Short tons	537,273	566,797	511,831	643,430	622,325	635,781	625,469
Carbon Black:							
% of total	93.1	94.4	93.5	93.5	95.5	45.5	95.3
Clay, Kaolin:							
Short tons	240,982	241,052	247,431	257,223	268,157	301,185	282,493
% of total	13.2	12.8	13.2	11.9	12.0	14.0	17.1
Clay, Fire & Stoneware:							
Short tons	9,322	18,475	8,781	2,928	.....	.....	.....
% of total	0.1	.2	.1	.2	.....	.....	.....
Lime:							
Short tons	2,000	1,631	1,555	1,465	2,487	2,799	2,533
% of total	(d)	(d)	(d)	(d)	(d)	(d)	(d)
Litharge:							
Short tons	2,109	2,230	1,768	1,947	2,266	1,298	1,247
% of total	1.1	1.4	1.3	1.3	1.7	1.7	1.4
Lithopone:							
Short tons	1,523	1,723	1,701	2,163	2,000[e]	.....	.....
% of total	2.5	3.3	3.9	5.0	5.0	.....	.....
Mica, Ground:							
Short tons	5,126	5,668	5,021	7,339	7,021	8,579	9,622
% of total	7.0	7.8	6.3	6.9	8.0	9.0	9.9
Sulfur:							
Short tons	84,000	89,600	84,000	89,600	89,600	89,600[e]	.....
% of total	1.4	1.4	1.3	1.2	1.1	1.1	.....
Talc: [b]							
Short tons	64,476	61,408	58,139	38,309	30,253	28,532	36,889
% of total	10.9	10.0	9.7	5.4	5.0	6.0	6.5
Zinc Oxide:							
Short tons	72,774	78,439	71,058	86,677	80,459	81,745	68,176
% of total	51.2	52.7	50.7	51.5	51.9	54.0	46.5

Source: U. S. Bureau of Mines.
Notes: (a) Solid and semi-solid products of less than 200 penetration (b) Includes prophyllite and ground soapstone. (c) Does not include precipitated antimony sulfide as in previous years. (d) Negligible. (e) Estimated.

Reclaimed Rubber

(Including Natural and Synthetic)

(All Quantities in Long Tons)

Year	New Supply	Consumption—Tons	Consumption—% to Crude [a]	Exports	Stocks On Hand at End of Period
1941	274,202	251,231	32.2	13,851	41,750
1942	286,00[illegible] [b]	254,820	64.6	30,405	42,532
1943	304,058 [c]	291,082	59.6	15,678	46,201
1944	260,631 [d]	251,083	35.3	11,800	43,832
1945	243,309	241,036	30.2	13,413	28,155
1946	295,612	275,410	26.5	14,461	33,666
1947	291,395	288,395	24.8	14,556	35,943
1948	266,861	261,113	24.4	11,428	32,053
1949	224,029	226,679	22.5	10,637	28,263
1950	314,008	303,733	24.1	11,740	35,708
1951	366,700	346,121	26.6	14,722	45,082
1952	274,981	280,002	22.2	11,180	30,664
1953	298,336	285,050	21.3	11,597	32,319
1954	258,101	249,049	20.2	10,232	30,746
1955	326,649	312,781	20.4	13,988	31,498
1956	287,220	270,547	18.8	13,832	34,969
1957	271,647	267,352	18.2	13,021	29,323
1958	259,809	248,156	18.2	11,362	29,063
1959	303,479	286,410	20.0	11,757	27,738
1959:					
Oct.	28,255	26,022	17.6	964	27,393
Nov.	22,525	20,217	16.1	909	28,526
Dec.	23,720	22,962	17.4	1,055	27,738
1960:					
Jan.	26,532	26,540	18.9	1,106	29,031
Feb.	27,085	25,944	18.6	1,258	28,653
Mar.	29,114	26,625	18.4	1,542	29,719
Apr.	26,221	24,210	18.2	1,248	30,916
May	25,676	23,763	17.8	1,167	32,611
June	25,516	24,677	17.8	1,164	31,699
July	21,512	19,249	16.8	1,384	33,624
Aug.	23,540	21,452	16.3	951	33,979
Sept.	22,306	22,101	17.8	1,028	33,949
Oct.	23,546	23,269	18.5	....	33,519

Source: U. S. Department of Commerce.
Notes: (1) These figures are revised from time to time and the latest available issue should be consulted for the most accurate data. [a] Includes natural and synthetic rubber. [b] Includes 893 tons of imports. [c] Includes 67 tons of imports. [d] Includes 21 tons of imports.

Cotton, Rayon and Nylon Tire Fabrics

(In Thousands of Pounds)

	Production—Rayon Tire Cord Net Woven	Production—Rayon Tire Cord Woven	Production—Cotton and Nylon Cord & Fabric [a]	Production—Chafer Fabrics (all fibers)	Production—Total Tire Cord and Fabric	Stocks [b]—Cotton and Nylon Cord & Fabric	Stocks [b]—Rayon Cord and Fabric
1958:							
Jan.-Mar.	8,372	56,522	25,647	7,367	92,924	11,255	33,913
Apr.-June	.....	.....	30,745	6,020	80,533	11,274	26,327
July-Sept.	.....	.....	31,371	6,467	91,984	11,229	26,428
Oct.-Dec.	.....	.....	34,858	8,466	107,532	12,251	25,936
Total	8,372	56,522	122,621	28,320	372,973	46,009	112,604
1959:							
Jan.-Mar.	77,307	77,307	41,565	9,163	122,661	14,025	22,093
Apr.-June	76,265	76,265	37,102	7,699	116,965	16,811	31,094
July-Sept.	76,671	76,671	39,863	8,318	119,748	14,040	35,152
Oct.-Dec.	.....	.....	.....	.....	.....	.....	.....
Total	.....	.....	.....	.....	.....	.....	.....

Source: Bureau of the Census, U. S. Department of Commerce.
Notes: (a) Combined to avoid disclosing figures for individual companies. (b) At end of period.

Gasoline Consumption

(In Thousands of Barrels of 42 Gallons)

	1954	1955	1956	1957	1958	1959	1960
Jan.	89,634	96,397	100,642	109,295	107,281	114,720	111,311
Feb.	86,206	88,464	98,088	96,694	95,516	99,759	108,871
Mar.	101,549	105,684	112,412	113,166	108,914	118,995	120,497
Apr.	103,866	111,116	113,034	115,820	118,477	124,917	129,094
May	104,418	115,707	123,560	124,325	125,137	127,049	129,952
June	113,037	120,710	126,833	121,598	125,444	133,695	138,909
July	112,231	115,653	120,708	130,251	130,903	137,141	135,838
Aug.	110,223	121,816	125,847	128,808	129,925	132,875	138,371
Sept.	104,706	113,379	111,574	113,567	120,389	130,264	128,530
Oct.	105,607	112,558	119,204	119,334	125,097	120,858	.....
Nov.	102,393	109,212	112,113	107,705	110,587	116,056	.....
Dec.	104,258	111,034	108,096	112,691	120,305	123,587	.....
Total	1,238,346	1,321,730	1,372,116	1,393,254	1,417,975	1,479,907	.....

Source: U. S. Bureau of Mines.

U. S. Gross Imports of Balata, Jelutong, Gutta-Percha, etc.

(All Quantities in Long Tons)

Year	Balata—Tons	Balata—Value	Jelutong—Tons	Jelutong—Value	Gutta Percha & Other Guttas—Tons	Gutta Percha & Other Guttas—Value
1949	1,391	814,554	1,043	834,978	197	189,021
1950	2,117	1,589,885	1,789	1,515,162	541	745,418
1951	2,452	1,973,271	1,569	2,608,359	383	430,539
1952	988	762,994	1,636	2,094,983	282	385,890
1953	1,619	866,248	1,027	1,166,837	235	303,116
1954	949	504,065	2,196	2,624,926	417	511,055
1955	1,022	967,369	1,679	1,731,821	284	318,115
1956	1,396	1,111,165	1,851	1,909,447	290	309,615
1957	1,037	670,821	1,680	1,942,067	230	270,487
1958	745	536,820	1,501	1,698,840	157	224,499
1959	1,512	1,350,843	1,296	1,608,986	268	311,178
1960:						
Jan.	144	219,497	84	100,515	47	57,798
Feb.	37	38,260	165	143,255	12	12,855
Mar.	47	42,000	37	44,269	4	15,197
Apr.	56	35,560	97	104,711	18	33,181
May	86	79,553	76	88,209	64	90,252
June	75	59,506	128	142,962	35	45,136
July	108	144,740	68	76,761	24	56,317
Aug.	207	213,484	88	99,726	35	55,090
Sept.	960	540,589	26	27,889	28	38,363

Source: U. S. Department of Commerce.

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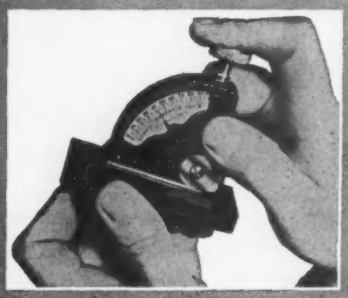

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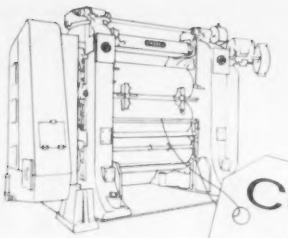

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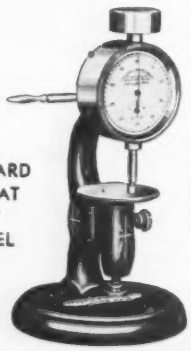

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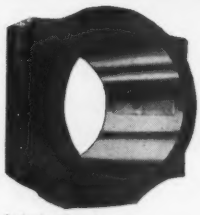

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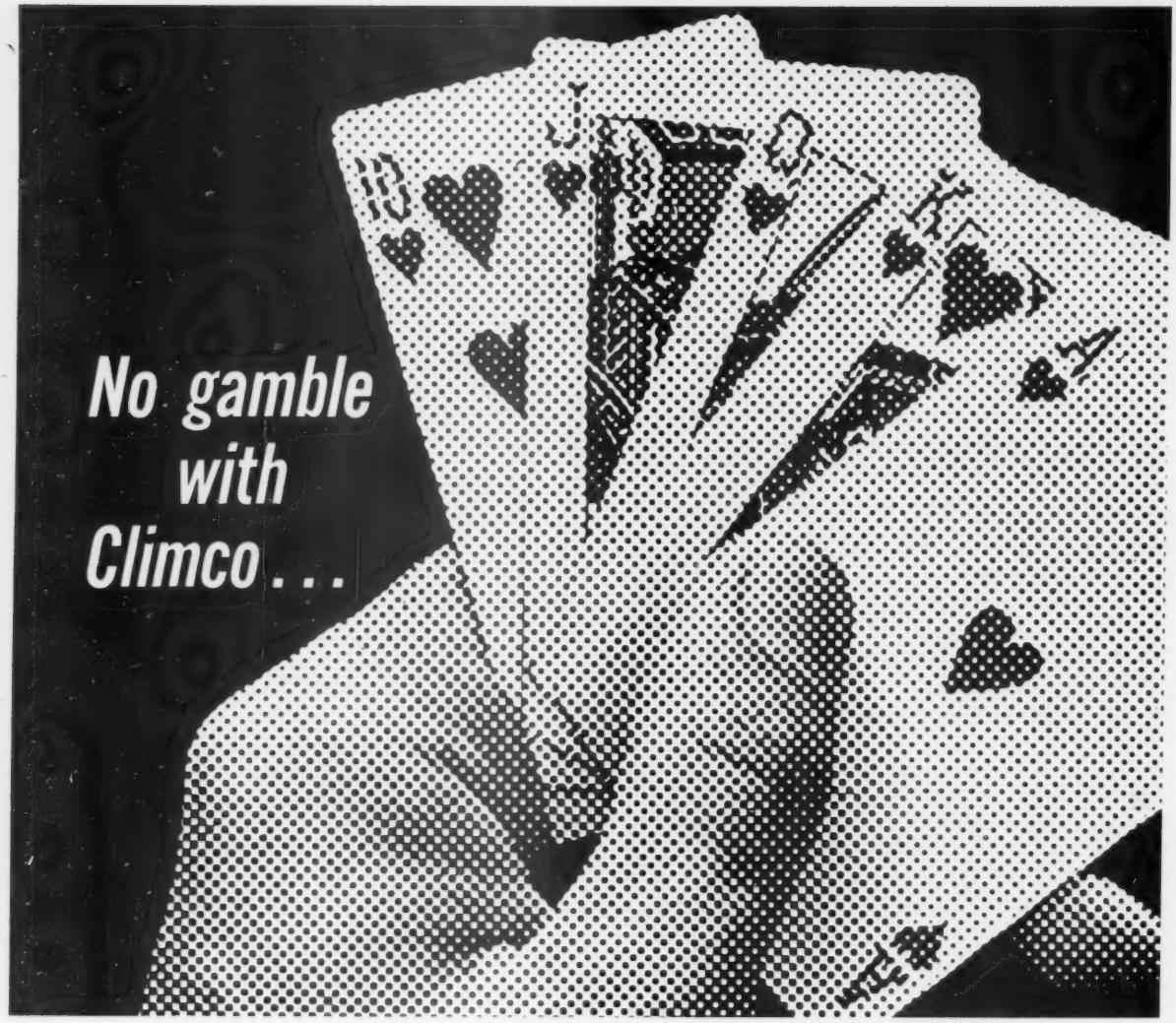

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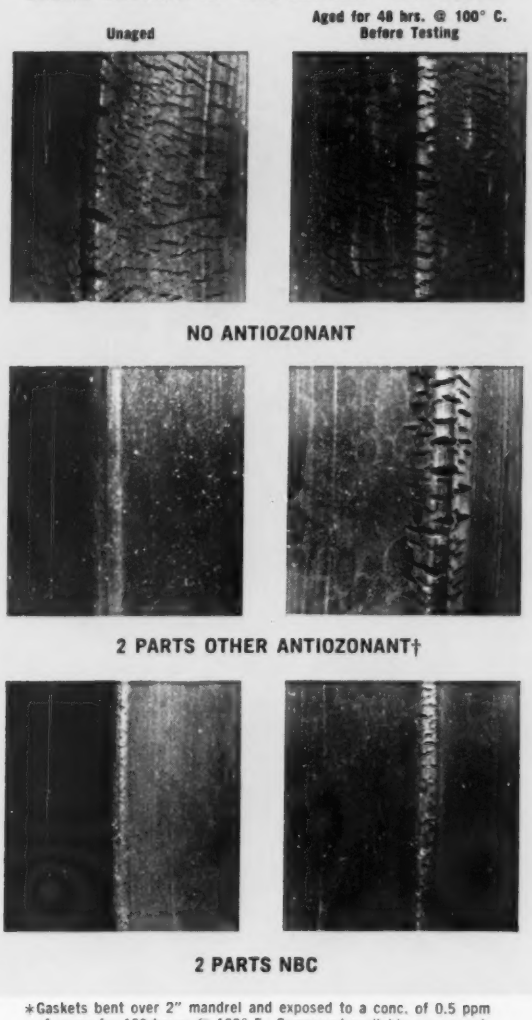

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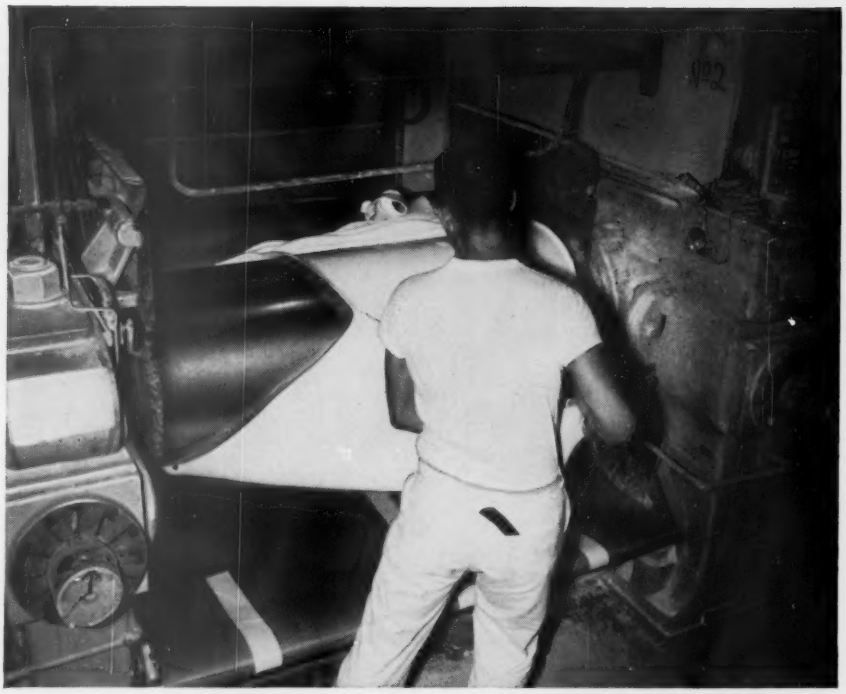

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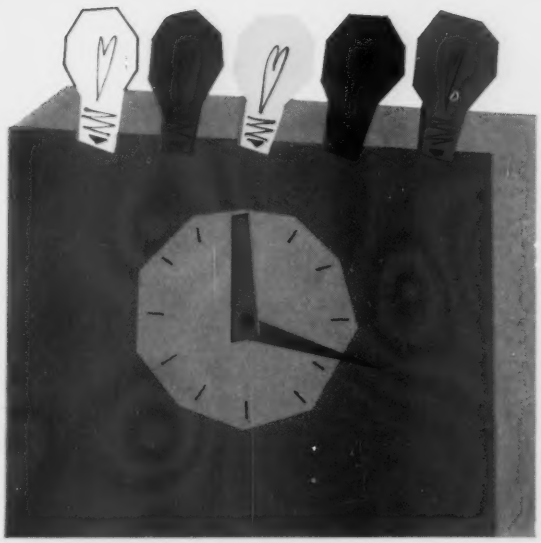

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